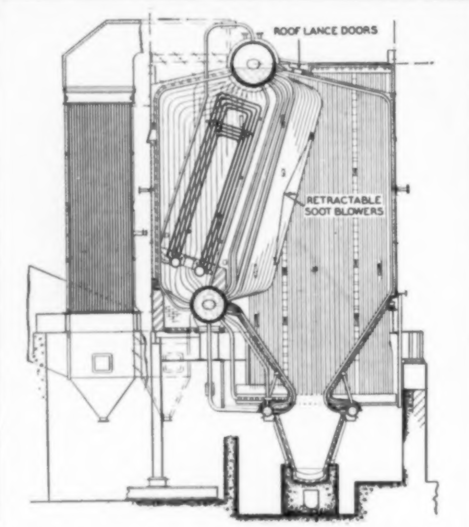
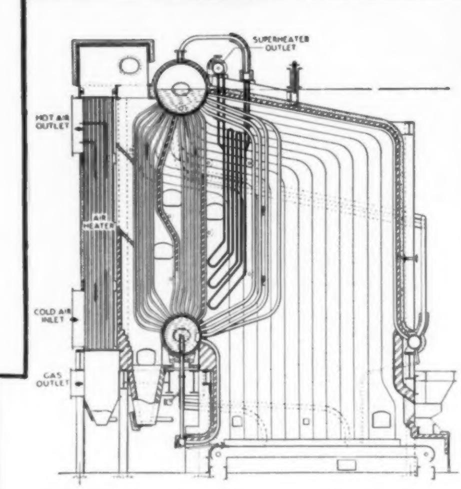
MECHANICAL ENGINEERING

APRIL 1945



Integral-Furnace Boiler in a mid-western steel plant—capacity 169,000 lb. steam per hr.



Stirling Boiler in a western manufacturing plant—capacity 115,000 lb. steam per hr.

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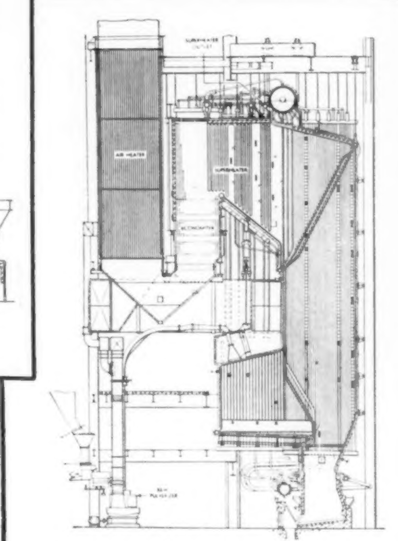

Radiant Boiler in an eastern central station —capacity 900,000 lb. steam per hr.

To managements, engineers, and operating personnel of public utilities and industrial power plants throughout the nation, B&W too, says "WELL DONE" for another year of distinguished war-time achievement.

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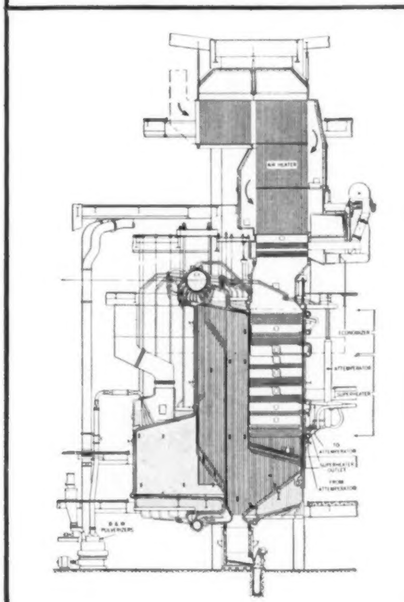

Open-Pass Boiler in an eastern central-station—capacity 900,000 lb. steam per hr.

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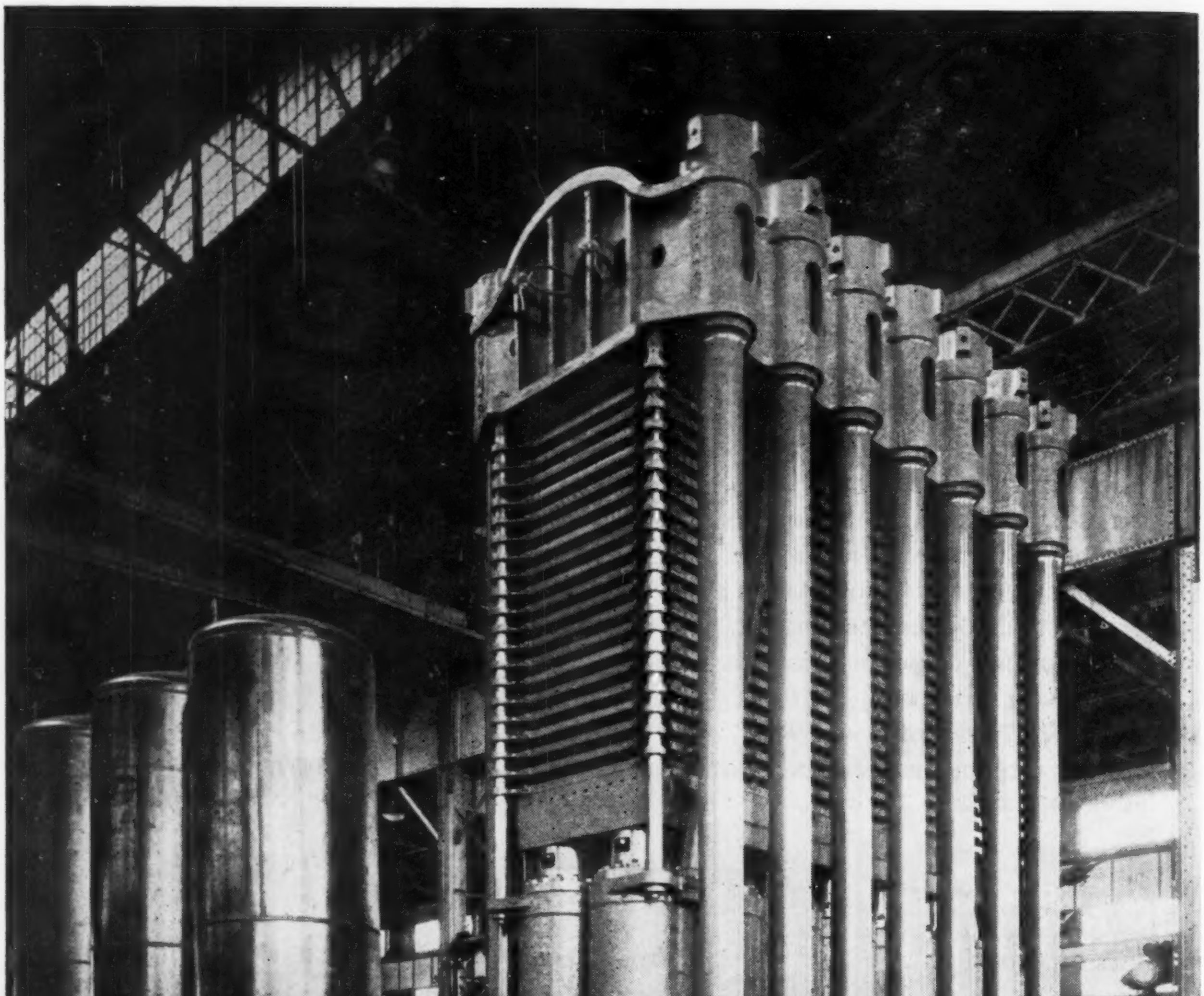


Southwark Division, Baldwin Locomotive Works

Large Steam Platen Press to Form Fiberboard Under Pressure of 9500 Tons

VOLUME 67
No. 4

MECHANICAL ENGINEERING

APRIL
1945

GEORGE A. STETSON, *Editor*

It Makes Sense

MANAGEMENT officials and personnel men who are laying plans for the employment of returning veterans, among whom there will be a number of handicapped persons, will find a helpful discussion of their problem in the short article, "Hiring Handicapped People," by Michael Supa, published in this issue.

What Mr. Supa has to say seems to make sense, not only from the point of view of the employer but also for the handicapped person as well. At one time or another, each one of us has to make some adjustment to a changed set of conditions. To the normal person, physically and mentally without serious handicap, these adjustments may not be easy but are readily overcome if we face up to them with determination and assurance.

Physical handicaps may restrict fields of action. Psychological hazards are more difficult to overcome. History records conspicuous examples of failure and success in the face of these handicaps. The situation calls for intelligence and realism—adoption of a positive attitude, as Mr. Supa puts it—rather than emotionalism and unwanted charity.

On this same subject Prof. Robert Widdop, of the Newark College of Engineering, has written a little pamphlet, "The Soldier Returns to Industry." Here again the same constructive positive philosophy is to be found. "The most important factor in his [the veteran's] readjustment is his active participation in normal civilian affairs as soon as possible after his discharge. Normal civilian affairs include duties, pleasant and otherwise, and most importantly, work. . . . The morale-building effects, the therapeutic value of work, are difficult to overestimate. . . . One just cannot overlook the effect of the pay envelope in matters of adjustment at work and at home."

Keep Programs Alive

POSTPONEMENT of national engineering meetings lays a heavy responsibility on program-making agencies and publications. It offers an opportunity for local meetings to take over the valuable services that national meetings normally perform. Unless engineers are willing to submit to a slowing down or even stoppage of the flow of engineering information, they will arouse themselves to do the best job possible under the handicaps of the times. The American Society of Mechanical Engineers is one of many engineering groups that has planned to reorganize temporarily its procedures so that it can carry on its work under new restrictions that have been laid upon it.

On page 279 of this issue will be found an appeal to A.S.M.E. program-making agencies, the 70 sections of the Society, and prospective authors.

The program-making agencies are strongly urged to continue the solicitation of papers in the fields in which they have the responsibility of drawing out the best and most up-to-date technical material.

It is suggested that the sections invite authors who had planned to address national meetings to present their papers before local groups where the advantages of active discussion and debate can be secured.

Authors are assured that papers submitted to the Society will be reviewed by the same groups and under the same procedure usually employed when national meetings are being planned.

Papers recommended by the professional divisions and technical committees will be published even if they cannot be presented at meetings. Discussion of these papers is to be encouraged, and publication of the discussion is part of the plan. In order not to delay publication of the papers submitted, recommended, and approved, every effort will be made to print them in MECHANICAL ENGINEERING and Transactions as soon as possible. It will be necessary to postpone printing of the discussion until later issues, as time must be allowed readers to study the papers published and prepare discussions of them.

If program-making groups, the sections, and authors co-operate fully, the ill effects of postponing national meetings can be minimized and the work of the Society will go forward.

Fighting Forest Fires

AN article in last month's issue proposed the formation of a joint committee of the Society of American Foresters and The American Society of Mechanical Engineers "to give advice and direction in the research, design, and development of equipment used in forestry work, particularly in forest-fire control, and in the forest-products industries." On page 290 of this issue the personnel of this joint committee is announced.

The A.S.M.E. Wood Industries Division, to whom the appeal for co-operation was originally made at the 1944 Annual Meeting, deserves credit for promptness and imagination in accepting the proposal. But the Wood Industries Division alone cannot do the job contemplated; nor would the proposal probably have been made to it if it had been an independent society instead of one of many professional divisions in a great society having numerous and broad interests. For the assistance that is needed in the proposed program must be rendered by designers and manufacturers of a wide variety of equipment.

Here is a striking example of the advantage of an engi-

neering society organized along the lines of the A.S.M.E. Broadly dedicated to mechanical engineering, the Society's technical work is carried on by professional divisions, each in itself a society within the framework of the entire group, and by committees engaged in special problems of education, research, codification of engineering practices, and standardization. Breadth and variety of technical and professional interest make it possible to find experts in hundreds of fields. Society organization affords opportunity for close co-operation of groups having different but related interests for undertaking broad programs. Meetings and publications bring to each member knowledge of what is going on in many other fields besides his own. The cross-fertilization of ideas and experiences that this setup makes possible pays rich dividends to individuals, to groups, and to the nation. What the foresters and the mechanical engineers are preparing to do through the joint committee just announced is one more evidence of the benefits that derive from the close co-operation of groups with different interests but common goals.

Education Our Common Interest

THE nation's achievements in supplying its Armed Forces with the best equipment and supplies in abundant quantities was no sudden stroke of genius. Talents and abilities came from peacetime establishments where they had been long employed. Science, engineering, and industry, the farm and the forest and the mine, the skills of finance, trade, and transportation were organized and put to work in a stupendous unified national effort. Back of it all was the experience with the particular job and the know-how that had been built up over many years and that were readily adaptable to the demands laid upon them. And back of these was education.

The educational backgrounds against which these achievements were made extend all the way from the public primary schools to the universities. They include the night schools, the trade and vocational schools, classes in adult education, the training courses offered by industries, the specialized professional schools, and the self-education that continues when active minds have felt the stimulus of formal education. Education has always paid large dividends, but never larger than those the nation has received during its fight for freedom. Indeed, the Army and Navy themselves have intensified the educational process in respect to the needs of fighting men and have made some extraordinary contributions in method and specialization that will carry over into peacetimes to serve the nation in reconverting its way of life to more normal conditions.

Impressive as our achievements, based on the extent, quality, and variety of our educational and training programs, have been, we would be foolish to be content with them and fail to expand and improve them. If the war has taught us anything it has taught us our nearness to the rest of the world; it has emphasized to us the closeness of our relationships with other peoples; and it has given us a wholesome respect for what they, ally and foe alike, have also accomplished. We face the realization that to keep our place in the progress of the nations of the world we must intensify our educational and training programs, broaden their scope, deepen their probing into the unknown, improve their quality, and extend their benefits to greater numbers of our people.

In some areas we have lost ground, and this we must regain as quickly as possible. Particularly in science and engineering, as well as other branches of professional education, we have interrupted the training of young men, dispersed faculties, and diverted research workers. How serious a handicap this will be for the future only time can tell; but the longer the war lasts the greater that handicap will be and the more slowly we shall overcome it. The universities are entitled to vigorous and ample support so that they may resume at as early a date as possible their task of educating young people for science and the professions and of reassembling their faculties and research workers.

The proponents of vocational training have been greatly encouraged by wartime conditions because the need for thoroughly trained experts, technicians, and mechanics has demanded thousands of courses of this type. No one will deny that skill in doing jobs by means of which men and women earn high wages is important if not essential. Highly skilled persons in an economy of full employment develop material standards of living and desires to possess and consume that are fundamental to full employment. Yet a balance must be struck between the training which develops these skills and an education by means of which living itself becomes a satisfaction in the rich experiences which life has to offer those capable of utilizing them to the full. A well-developed program of adult education would return to the nation unexpected benefits in the lives of its citizens and in the work by which they earn their wages. It is said, for example, that the Peoples High Schools of Denmark improved agriculture in that country even though the courses studied would be classed as cultural rather than vocational. Widely attended, such courses should have even greater benefits in an industrial nation like ours.

Another area in which adult education will return large dividends is the field of supervision and management where leadership is so important a quality. From the foreman to the president responsibilities have increasing burdens, and the responsibilities themselves are fundamental to our national economy. Advancement may come by promotion from the position of workman or operator through one supervisory position after another until the top is reached; or it may come through the systematic training of college graduates seeking careers in managerial capacities. But no one can contemplate the position of industry in our nation without coming to the realization that the best men with the broadest education and deepest understanding of the problems of national life find it a challenge worthy of their best efforts.

The war has put our past educational programs and policies to the test. Our nation has met the test better than many would have predicted. But education is still our number-one problem. It needs our best and most intelligent planning. And we need to remind ourselves always that it is a continuing experience for all of us. It is our common problem and our common interest.

POSTWAR AIR TRANSPORTATION

By C. E. McCOLLUM

GENERAL MANAGER, TWA CENTRAL DISTRICT, CHICAGO, ILL.

AVIATION in both its national and international phases is affecting the daily existence of civilization throughout the world. The importance of air transport as a factor in the military, political, and economic affairs of the world has increased with a rapidity unprecedented in the history of transportation. Little more than ten years ago the aviation industry was a mere infant, but in the memorable period since then the infant has grown to incredible and entirely unpredictable size. Now it has received universal recognition as a major industry and as one of the two or three most important factors in the successful prosecution of the war. This is the new giant that is destined to help shape the affairs of the postwar world.

Our nation, which has supported and largely paid for two world wars, can maintain its position of strength and prestige only by playing a role of equal importance over the world in peacetime commerce and other activity. The world, which has benefited from our participation in the war, from the billions of dollars of our resources we have sent out, the food, clothing, machinery, automobiles, trucks, aircraft, and other goods we have supplied to practically every country, cannot deny us the opportunity of peaceful trade when this war is over. If we are to maintain economic and military strength in peacetime, we must participate in the world's trade and economic development on a scale equal to our military participation in time of war.

Today, no two important points on the earth's surface are farther apart in time by air than are San Francisco and New York by train. Thinking of distance in terms of miles is useless and meaningless. Cruising at better than 300 miles an hour a Lockheed Constellation would take less time to go from Detroit to Moscow than a railroad train would take to go from New York to Chicago. From Minneapolis to New York by train takes longer than going from Minneapolis to Tokyo by air.

Such schedules are not of the dim future; they are simply realities of today, although most of us cannot take advantage of them, because of the war. The Air Transport Command of the Army Air Forces has spread a vast network of air lines across the continents to every corner of the globe. The Navy's Air Transport Service has done likewise. Several domestic air lines have crews flying these routes today under contract with the Army. By actual practice, their scheduled daily operations have proved the often repeated statement that the airplane has brought any place in the world within sixty hours' or less flying time from any other place. Only recently TWA's Intercontinental Division completed its 6000th ocean flight, and in February, 1945, it will have completed three years of daily intercontinental operations. In 1944 alone, the Transcontinental Division of TWA flew more than 14,000,000 plane-miles across oceans to the world's battle fronts, and this is more than half the plane-miles TWA flew in its busy coast-to-coast air-line operations here at home. In 1944 the Air Transport command as a whole was dispatching one transatlantic flight every 19 minutes.

WORLD-WIDE AIR ROUTES PLANNED

From this it will be seen that the air lines are only waiting for the "go" signal to commence world-wide commercial flying. Decisions are being made today that bring the promise of round-the-world flight ever closer. In June, 1944, TWA filed with the Civil Aeronautics Board an application for the first round-the-world route proposed by any air line. Based on serving the most important commercial, military, and diplomatic interests of the United States, this route goes through 31 countries and serves ten of the earth's 26 important international traffic generating areas.

The Civil Aeronautics Board itself has outlined 130,000 miles of proposed over-ocean routes and is holding public hearings on applications of various carriers to fly these routes. TWA's proposed route covers 22,000 miles, from which it can be seen that there is ample room for the free exercise of competitive effort among the carriers of our own and other nations.

TWA has been thinking of this round-the-world route for a long time. It will be recalled that Howard Hughes, who with TWA president, Jack Frye, conceived and developed the Constellation, flew around the world some years ago in three days and 19 hours, a record which still stands. This flight fired Mr. Hughes's interest in a commercial round-the-world route. Early in 1939, TWA started developing the Constellation, for a cruising range of more than 4000 miles. You will all recall, in April 1944, Mr. Hughes and President Frye piloted the first Constellation, on a delivery flight to the Army, from Burbank to Washington in a record 6 hours, 57 min, and 51 sec. Constellations have gone to war, of course; but when their military mission is ended, they will begin commercial service.

TWA has put more than five years of study and effort behind its world-route program. If it secures the world route it is seeking, a passenger can fly around the world in one airplane in 76 flying hours. The Constellation has been scheduled to fly around the world without being tied up for mechanical inspection or maintenance. It will not be necessary even to change the engine oil during the trip. This is the airplane of today, tomorrow, and the next few years.

What does the establishment of such a route mean to Detroit, for example? It means that the manufacturer, who up to now has been confined largely to the United States, can with the same effort do business everywhere in the world. A world air route will mean that the automobile manufacturers can send spare parts to Karachi, for instance, in the time it now takes to ship them to Los Angeles. It will be easier for the manufacturer to secure competent dealers because they won't need the large capital it takes to carry heavy inventories. The manufacturer can have more dealers and more service stations, and can maintain quick and economical contact with them in person. The opportunities are obvious and endless.

These opportunities are close at hand. TWA already has filed schedules and fares for Constellation service from the United States to Europe, North Africa, and the Far East, and has ready the flight schedules for its entire round-the-world route. Let me illustrate.

AROUND THE WORLD IN FIVE DAYS

TWA's daily eastbound Flight 112, for Detroit and Chicago passengers, takes off from the Detroit airport at 10:40 a.m. and speeds directly to Stephenville, Newfoundland, arriving there at 4:45 p.m. Stephenville is the "jumping off" place for North Atlantic routes. From here we can take either the longer route through Greenland and Iceland, which permits shorter distances between stops, or the express route which spans the whole North Atlantic in one flight. Flight 112 follows the

Presented at a meeting of the Detroit Section, Detroit, Mich., Jan. 25, 1945, of The American Society of Mechanical Engineers. Slightly abridged.

quick express route, the fastest service ever scheduled for such a journey. We take off at 5:15 p.m. and climb into the skies. But even at altitudes up to 30,000 ft, the Constellation's cabin is comfortable because it is "pressurized" to maintain ground-level atmosphere. The Constellation picks up even more speed as it levels off above the weather. The 8800 horsepower in its four engines pull the plane through the thin air at better than 300 miles an hour. At 7:10 a.m. the next morning we are in London. It's still only 2:10 a.m. back home, since London is five hours ahead of Detroit by clock time. We have been just 15 hours and 30 min on the way. The fare from Detroit to London is $211.90, and this is at the rate of five and a half cents a mile, the same tariff we pay for domestic air line service today. In other words, with Constellations we shall double today's air speeds, increase comfort and service, and fly across oceans—but without any increase in fares.

From London we have a choice of routes through Europe to Cairo. We can take Flight 106 at 9 a.m. and fly to Berlin, Vienna, Belgrade, and Istanbul, reaching Cairo at 11:10 p.m. Or we can take a somewhat quicker trip aboard daily Flight 102 that leaves London at 10 a.m. for Paris, Milan, and Athens, reaching Cairo at 10:50 p.m. Flight 102 ends at Cairo but Flight 106 is a through plane to Calcutta, more than half way around the world from Detroit. Constellation Flight 106 takes off from Cairo at 1:25 a.m. While we sleep, the transport stops at Jerusalem and Damascus, but we awake for a look at the Bagdad airport while the Consellation refuels. Off again at 6:45 a.m., we are soon flying over the land where Christ was born, and where He lived and died—the land of the Tigris and Euphrates. We reach Teheran at 9:15 o'clock the next morning, and then continue our swift course to Karachi and New Delhi, landing in Calcutta at 11:33 o'clock that night.

It took us 29 hours and 10 minutes to reach Cairo from Detroit and the fare is $335.50. From Detroit to Calcutta, it took us 48 hours and 55 minutes and the fare is $540.90. (The present air fare from New York to Foynes, Ireland, is $575.)

Schedules have also been worked out for the remainder of the eastward flight around the world. We leave Calcutta on a Friday at 2 p.m. and arrive in Canton, China, at 9:45 o'clock that evening. During the day we have flown across the northern parts of Thailand and French Indo-China, and now we are close to the China Sea. Leaving Canton at 10:15 p.m., we land in Shanghai at 1:30 a.m. on Saturday. After a 30-minute stop, the Constellation is on its way to Japan, arriving at Tokyo at 12:05 p.m. Saturday. Leaving the Japanese capital at 12:35 p.m., we are soon high over the North Pacific. Then, as we cross the International date line in the Bering Strait, were gain the clock time lost as we traveled eastward. We cross the dateline early Sunday morning and find we are back to Saturday morning again. Anchorage, Alaska, appears below us and we land at 7:12 Saturday evening. From there we set our course for the first United States soil since leaving Detroit. We arrive in Seattle at 2:20 a.m. Sunday, bringing with us the Sunday newspapers we picked up in Tokyo—because *yesterday* was Sunday in Tokyo.

At 5:20 a.m. we are in San Francisco, and from there we follow TWA's shortest, fastest, coast-to-coast airway back to Detroit, only a little more than five days after leaving there on our 22,000-mile journey.

This is the kind of flight service the future will provide, and this world-wide commercial service is ready today so far as the carriers are concerned. At the recent North Atlantic route hearings before the Civil Aeronautics Board in Washington, TWA announced that it is prepared to start interim service now from New York to London, Cairo, and Calcutta with equipment it already owns. The TWA fleet of four-engine transports, the 38-passenger Boeing Stratoliners, which were turned over to the Government shortly after Pearl Harbor and for two and a half years were flown over the oceans in military service, has now been returned for commercial service. The TWA engineers and the engineers at Boeing have put these airplanes through an unusual reconversion process. The Stratoliners are the passenger version of the B-17 Flying Fortress. They have been equipped with new Flying Fortress wings, landing gear, and horizontal tail assemblies as well as more powerful Wright engines and a B-29 Superfortress type electrical system. A new "warm wall" air-conditioning system that works on the ground as well as in the air has also been developed for the Stratoliners.

It is proposed to use the Stratoliners on the international route to Calcutta as an interim service until Constellations are available. In the Stratoliner, a passenger can be taken from New York to London in less than 23 hours by way of Newfoundland, Greenland, and Iceland, for a fare of seven cents a mile, or $263.80 for the trip. This is less than half the present fare that high-priority passengers are paying to fly across the Atlantic. With five Stratoliners it will be possible to operate seven round trips a week to London, extending two round trips weekly to Cairo, and one round trip weekly to Calcutta. This can be done now. The schedule frequency proposed to CAB actually involves the daily operation of only four Stratoliners, with one held in reserve at all times.

INTERNATIONAL AGREEMENTS NECESSARY

If one or more air lines are ready to start international service, one may well ask: What is holding us back? The answer, of course, is the necessity for international agreements. In this connection, a brief report on the International Air Conference recently held in Chicago will be enlightening. It was the most important air conference ever held, and out of it came certain decisions which will vitally affect the operation of international air lines for all time to come.

The conference was called by the United States for the purpose of establishing certain fundamental air policies. Nothing like it had been held in the short history of aviation and much depended on what was decided there. More than fifty nations sent delegations to the conference and the only major power, excepting the Axis nations, that did not attend was Soviet Russia, but the door has been kept open to Russia for later consultations.

From the outset, it was apparent that Great Britain and the United States were sponsoring proposals of conflicting philosophy and practices. Great Britain strongly advocated a system of rigid control over international air transport and this control would be administered by a super international body. In this body would be vested wide powers to determine all routes and to establish rates, frequency of schedules and quotas, and even speeds. It was a sort of international Civil Aeronautics Board that Lord Swinton and other British delegates wanted.

The United States, on the other hand, wanted as little international control exercised as possible. We advocated the traditional American policy of competition. We believed, and still believe, that to hamstring air transportation just at a time when a period of great expansion is in sight would be to limit its future. If some international body, which is a polite name for cartelization, should be empowered to fix the number of daily flights that all countries could operate across the oceans, then these operations would soon settle into a rut and the public would be deprived of the service it would enjoy under competition.

Our side, as represented by Adolph Berle of the State Department, insisted that our own Civil Aeronautics Board should determine what United States companies should fly internationally and where they should fly. That was our position and still is.

In the lineup of nations on either side of these two conflicting positions, the United States was supported by the 21 Latin-American nations, the Scandinavian countries, and the Netherlands. Canada, at the outset, favored the British policy

slightly but later veered toward our point of view. France inclined toward the British view.

All of the conferees, however, were in solid agreement on the need for an international organization to establish uniform *technical* standards on such matters as weather reporting, communications, safety regulations and practices, and the like. Obviously, every nation flying into another nation could not operate according to its own code book and there had to be uniformity in operations practices and procedures.

After more than a month of consultation and debate, most of the conferees, including Britain and the United States, agreed upon two of the five so-called "freedoms" which the United States sponsored. The first was the right of a flag carrier to fly across the land of another nation without stopping, and the second was the right of a carrier to land in a foreign country for nontraffic purposes or, in other words, to refuel, to seek repairs, or to find refuge from weather.

Acceptance of the first freedom alone would have justified the conference. It was a historic concession, for it recognized for the first time the principle that the ocean of air flowing over a country should be utilized by all aircraft engaged in peaceful trade. Sovereignty of that air space was not surrendered by any one nation, but all agreed that it should be used for commercial purposes and should not constitute a bar to the development of international traffic.

The second freedom agreed upon also is of the highest importance because it permits international air lines to operate into and out of established fields for nontraffic purposes. Since this was written Newfoundland has signed the Two Freedoms Agreement.

These two freedoms are a long step forward in working out an international air policy. But the conference failed to come to a blanket agreement on the final three "freedoms" which the United States is advocating. These are: (1) The right to discharge passengers and cargo at a foreign port; (2) the right to take on passengers and cargo at that port and fly them to a home station; and (3) the right to take on and discharge intermediate traffic in countries along an international carrier's route. These matters, under the decision, were to be subject to bilateral agreements between individual nations.

The United States promptly signed a bilateral agreement with Spain, which will permit our flag carriers to operate three routes across the Atlantic into Spanish territory and to pick up and discharge passengers, mail, and cargo at specified points on these routes.

These routes are: (1) New York-Lisbon-Madrid-Barcelona; (2) from New York to Madrid and then to Algiers; and (3) across the South Atlantic to the Spanish West African port of Villa Cisneros and then to Seville, Madrid, and Barcelona. This agreement is now in force, and the United States could authorize any air lines tomorrow to start operations into these Spanish cities and possessions. In return for these rights, of course, Spain is granted reciprocal rights to operate with its air carriers to the United States. More recently, we have signed reciprocal agreements with Sweden and Denmark.

Many observers were disappointed in the conference because the agreements failed to cover the entire program. I do not feel this way. A good start was made toward later consultations, when we can reach multilateral agreements on the uncovered points. Meanwhile, the State Department must negotiate agreements to cover the rights of commercial entry with each individual nation—and that will take time.

If Great Britain stands fast in its refusal to permit United States flag carriers to take on and discharge passengers in her territory unless it is done on a quota, or a plane-for-plane basis, we will have run into a heavy snag. Such a policy would injure all world air transport, not merely the United States. It would be like deciding that only one British ship should be permitted to enter New York harbor for every United States vessel that docks at Liverpool. Transportation simply cannot be regulated in that fashion if it is to serve the greatest possible public good.

Up to now, thirty of the nations attending the conference have signed the Two Freedoms Agreement and nineteen have signed the agreement for all five freedoms. More nations are signing the various agreements as time goes by.

DOMESTIC AIR-TRANSPORT PROBLEMS

The domestic side of the air-transport problem is much like the international problem except that future possibilities are more obvious. We are fortunate in having long since established the policy of competitive enterprise, but we still must guard against the erection of artificial barriers against natural growth and expansion.

Today in our domestic airways system about 290 cities are certificated as route stops for air-transport service. Considering the metropolitan populations in these communities within a 25-mile radius of the cities themselves, only 64 per cent of the total population of this country is being served.

It has been estimated by Mr. Edward Warner, vice-chairman of the Civil Aeronautics Board, that 1000 points of service on airways could serve 88 per cent of the population and 2400 airport stops would serve 100 per cent of the population within a 25-mile radius of the certificated points in question. It is certain that much, if not all, of the additional number of communities necessary for full coverage will be certificated, and as these additional points receive service, there will be an increasing amount of the local type of service. Any air service must be operated frequently enough to attract business from the rails and buses and to create new business of its own.

TWA, the third largest air carrier in the United States from the standpoint of revenue and mileage, serves some 30 cities. However, recognizing the ultimate development which is necessary, TWA has applied for service to some 100 additional communities, all directly on or adjacent to our present routes. If these applications are granted, TWA will serve every community of importance from coast to coast along its system, providing trunk-line service for practically every city of 25,000 population or greater. It is proposed to serve these cities on a trunk-line basis because it is believed that all communities, regardless of size, are entitled to the same quality of service that is today limited to the larger cities. Flight schedules will follow an orderly "traffic flow" pattern that conforms to east-and-west operations.

Skip-stop service would be provided somewhat as follows: A flight operating between New York and St. Louis might stop only at Scranton, Williamsport, Pittsburgh, Springfield (Ohio), Indianapolis, and Centralia (Illinois). Other flights would serve the points skipped by the first flight and in turn pass by almost all of those where companion flights had stopped. Certain schedules would give purely local service, stopping at every point en route. Both skip-stop and local service will connect with our high-speed transcontinental flights whose schedules will be arranged to accommodate local traffic flowing into the main traffic terminals. But all the flights, as has been said, will follow the same general east-west direction.

It is believed that this is the logical, most economical, and most serviceable way to handle the growth of air transport.

Another school of thought has proposed a widespread system of so-called "feeder" lines which would bring traffic into the metropolitan centers from outlying communities through a series of stub-end lines, much like the spokes on a wheel. At a hearing before the Civil Aeronautics Board, a determined effort was made to have the board adopt the feeder-line method as a policy for future routes development. The Board, however, rejected this proposal and decreed instead that every case in the future, as in the past, must be decided on its own merits. Thus the operator who can show he is in the position to provide the most service to the people of a specified community will

get the certificate. That is as it should be, and TWA heartily concurs.

FUTURE GROWTH OF AIR TRANSPORT

What growth in air transport can we expect in the future? Looking into the future is a difficult task, but looking back on the past may help to point the way. In 1931 there were 470,000 passengers carried by the domestic air lines. In 1941, ten years later, more than 4,000,000 were carried. This is an increase of 764 per cent. Would anyone have prophesied this increase in 1931? I am frank to say I do not know of anyone who *did* make such a prophesy, but I am going to say that it will happen *again*. Conservative estimates by traffic authorities are that air traffic will increase 500 per cent within the first decade after the war. For my part, I think this is decidedly conservative, and we have only to look at the history of the railroad and the automobile to see why.

In the period from 1890 to 1914, the railroads were almost alone in providing intercity transport within the United States. Their growth in passenger-miles was markedly faster than the companion growth of population, the national income, and the extension of railroad lines themselves. By the same token, it was estimated by some authorities in 1910, when the automobile was first recognized as a factor in the travel field, that the number of automobiles needed for such travel as was then provided by horse and buggy would never exceed 10,000,000 cars; and it was widely agreed that a reasonable estimate would be 5,000,000 cars. Actually, passenger-car registrations turned out to be 23,000,000 by 1930 and 27,000,000 by 1940, and the total automobile passenger-miles traveled in 1940 was close to 500 billion miles. It is a well-established fact that when any new form of transportation is accepted by the public, the newly created travel market is many times greater than the amount of travel that would have been realized if based on past trends. In other words, improvements in modes of travel bring about an increase in *all* travel and create new traffic that did not exist before.

Aviation will offer better accommodations because the airplane provides more speed, more convenience of service, and equitable rates. But do not for a moment think we are not anticipating competition. The railroads and bus lines will not be idle. A majority of the roads favor a reduction in fares immediately after the war. Most of them recognize that their present equipment is outmoded and plan to modernize and increase their rolling stock. They want to increase their postwar speed and comfort to new high standards. The air lines expect rail travel will *increase*, not decrease.

In the *Wall Street Journal* recently, C. E. Newton, president of the Chesapeake and Ohio, predicted transcontinental passenger-train service, without changing cars en route from coast to coast, through collaboration of eastern and western roads. Mr. Newton said, "If the railroads are farsighted and are willing to go all out to make a real competitive bid against the air lines for passenger traffic, we believe they can more than hold their own." The article went on to say that introduction of a through passenger service from coast to coast would have special appeal to many transcontinental travelers, after the *novelty* of flying has worn off, according to Mr. Newton.

I think we will all agree that the airplane is somewhat past the novelty stage, but it certainly would be a novelty to be able to ride in the same train from coast to coast, a type of service that has been standard on the air lines for fifteen years.

Because the airplane can and will create much of its own traffic, we in the air lines believe we can expect a tremendous growth if we are allowed to expand normally. Normal expansion means freedom from unnecessary restrictions. Any attempt by the various state governments to enact laws regulating interstate air transportation would deal a crippling blow to progress. A new industry cannot afford to be hamstrung by duplicating legislation, because if it is, potential investors will be discouraged and there will be no new capitalization with which to expand. This is no special pleading, but simply a matter of plain business fact.

Railroad building in this country would never have reached the proportions it did if it had been hampered by a welter of local laws. On the contrary, railroad building was stimulated sharply by federal, state, and local concessions of a magnitude which the air lines of this country do not expect or need. By its very nature air transportation is less costly than most other forms of transportation but it cannot develop if it is saddled by excessive taxation, needless legislation, various forms of cartelization, or any other confining or restrictive devices.

We know what has happened in the trucking industry—a major industry that is trying to rise in the face of a vast confusion of restrictive state laws. Trucks in interstate commerce must conform to new regulations at every state border. These regulations unquestionably have been a very serious detriment to the trucking industry, and a nation-wide uniform trucking law seems to be the only way out.

To quote L. Welch Pogue, chairman of the Civil Aeronautics Board, in a recent address at St. Paul: "Artificial, man-made barriers of innumerable types and kinds have in the past been placed across the road of progress in every branch of transportation and commerce. By slow and laborious steps they have for the most part been swept aside but at terrific cost to society, which is needlessly denied, for a time, the advantages which could flow from a readier adoption of sound and progressive ideas."

In the case of the airplane, we believe America should profit from history and not make the same mistakes again. Let us this time create a new major industry—air transport—without the costly man-made barriers of restrictive laws.

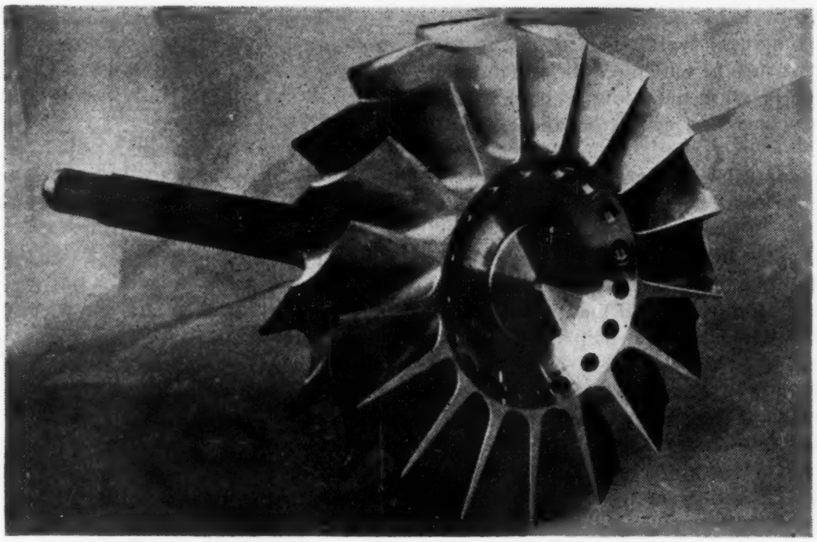
FASTER AIRPLANES ALREADY BUILDING

As previously mentioned, TWA expects to give wartime air travelers an early preview of what postwar air travel has in store for them when the Stratoliners are put back into commercial service. Their 200-mile speed is slow by the latest standards, but far faster than any presently available air-line equipment. With them transcontinental service in less than 14 hours is possible. With the Constellation this time can be reduced to about eight hours, Los Angeles to New York. The forthcoming Douglas DC-6 is comparable in size and performance to the Constellation, and Douglas also has in work the DC-7, an 84-passenger plane with speeds up to 400 miles an hour.

Recently it was announced that the first experimental model of the Boeing Stratocruiser—passenger version of the Superfortress—flew from Seattle to Washington in just six hours; and this is at the rate of 400 miles an hour. The Stratocruiser will carry 100 passengers.

A little further ahead is a 90-passenger Lockheed, the big brother of the Constellation, and beyond that is a 400-passenger transport being built by Consolidated. Jet propulsion also must be considered; many transports now on the drawing boards call for jets to attain quicker take-offs with full loads. Gas turbines are just around the corner. The war has put us many years ahead in aircraft design, and while the general public cannot get a firsthand view at present, the full measure of air-transport progress will become apparent at the end of the war.

A good example of what can be expected in postwar air service is contained in a recent statement by President Frye. He said that sleeper service on the Constellations in coast-to-coast service was not contemplated. He pointed out that after a New Yorker had boarded the plane, read a newspaper, had a cocktail in the airliner's lounge, finished dinner, and chatted with other passengers for a while, he would not have time to go to bed. He would be in Los Angeles.



MIXED-FLOW TYPE TURBINE RUNNER WITH COOLING-AIR PASSAGES

HIGH-TEMPERATURE GAS-TURBINE POWER PLANTS

By J. S. HAVERSTICK[1] and A. M. G. MOODY[2]

DE LAVAL STEAM TURBINE COMPANY, TRENTON, N. J.

THE number of possible variations of the constant-pressure gas-turbine cycle is enormous, and it will be many years before the final test of practical application has ruled out many of them. Meanwhile, all that can be done is to study as many of the variations as possible and decide which are the most promising, on the basis of reasonable assumptions as to the performance of the component parts of the system.

A great deal of the discussion of gas-turbine cycles has centered around the question of the maximum permissible turbine-inlet temperature. The basic cycle is extremely sensitive to variations in this temperature, as has been shown in numerous publications.

To date, two schools of thought have been heard from: (*a*) Those who, assuming that a reaction turbine will be used, say that 1100 to 1200 F represents the maximum practical temperature. These in turn might be subdivided into two classes, i.e. those who say this is high enough to make the gas turbine commercially feasible right now, and those who say it is not. (*b*) There are those who believe that by using an impulse stage, perhaps with velocity staging, the temperature can be dropped to such an extent that much higher initial temperatures, perhaps 1500 F, can be handled with present-day metals.

To these we wish to add a third point of view. Recognizing the handsome gain in cycle efficiency which results from using 1500 F instead of 1200 F we want to capture this, and without having to use an inefficient initial stage. We have therefore been led to study the possibilities of using air from the compressor to cool the parts of the turbine which are subjected simultaneously to high stress and high temperature. Naturally, this too involves some loss, but it was hoped that the loss need not be serious. Some of our findings will be discussed.

AIR-COOLING GAS-TURBINE BLADES

Various systems have been proposed for air-cooling gas-turbine blades and wheels. The crudest is to direct a jet of cold air against the wheel or the blade fastening. This is not too effective in removing heat, and the handling of the cooling air must all be charged in the loss column. The system is simple to apply but cannot be used where efficiency is an important consideration.

A second system, applicable to an impulse wheel, is to supply cold air to one group of nozzles immediately following the hot gas nozzles. Thus a stream of cold air passes over the blades and cools them. This method offers the possibility of fairly effective cooling without incurring as great a loss as occurs in the first mentioned system. The pressure drop in the nozzles may be considerable, but under favorable circumstances some useful power is developed, so that the net loss is not great. Under unfavorable conditions, that is, where the blade proportions are not suitable for proper flow of the cooling air, this system may entail a drag on the turbine wheel, and thus be less satisfactory than the preceding one.

A third system is that which is assumed for the present study. It involves the provision in the turbine wheel of passages through which cooling air can flow. It is assumed that the passages are designed for shockless entrance and exit, and that little pressure loss is suffered by the cooling air. This system can give excellent cooling with minimum loss.

The cooling of the casing, though less serious than that of the rotating parts, must not be overlooked. It need not, however, be a difficult problem.

[1] Mem. A.S.M.E. [2] Jun. A.S.M.E.

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For the present study, a cycle has been assumed which has a low- and high-pressure compressor, with intercooler between, one combustion chamber, a turbine which for convenience will be assumed to have a high-pressure and a low-pressure section, a power-consuming element such as a generator, and a recuperator.

Air is bled from the compressor at some intermediate point and is taken to the high-pressure turbine, where it is used to keep the high-stressed parts of the vanes cool.

As the cooling air leaves the high-pressure turbine, it mixes with the main gas stream. A small amount of reheat is introduced, and the entire mass, composed of the main flow plus the cooling flow, enters the low-pressure turbine, from which it goes on to the recuperator.

In practice, if the amount of reheat is small, it may be omitted. In order to make it possible to draw conclusions about cooling, it is desirable to assume that reheat will be included even in cases where the amount is quite small.

Since this arrangement is rather complicated, tending to make calculations confusing, certain simplifications and idealizations have been assumed. In the first place, the cooling air will be treated as a separate cycle, which never mixes with the main cycle. Then it will be assumed that no heat transfer occurs between the two streams, but that fuel is burned in the cooling-air stream to bring its temperature up to the temperature of the main stream as the latter leaves the high-pressure turbine. But, in recognition of the fact that both cycles actually use the same low-pressure compressor and turbine, the same efficiencies will be assumed for the two.

These assumptions call for some justification. Referring to the assumption that no heat transfer occurs between the hot gas and the cooling air, it must be admitted that, after all, the main purpose of using the cooling air is to remove heat from the hot gas. But consider, for example, a pure impulse stage where, after it leaves the nozzle, the gas stream experiences no drop in pressure, but only a deceleration produced by the moving blades of the tubine. Even if heat is removed from the gas stream as it crosses the blades, the gas need not experience any further change either of pressure or of velocity, provided the entrance and exit areas are properly proportioned. Thus, the hot gas stream does not care whether heat is removed as it crosses the blades or immediately after leaving them.

As for the cooling air, it is also immaterial, as far as the mechanics of the flow is concerned, whether heat is put into it while it flows through the cooling passages or immediately after leaving them.

One other assumption may seem to depart from the true situation. The cooling air in reality does remove heat from the main stream, thereby reducing the energy available for the low-pressure part of the expansion. Let us, however, consider some actual figures. Assume that 1200 F is the maximum initial temperature (not blade temperature) which an uncooled turbine can stand. Then suppose that in the high-pressure turbine we can, by the use of cooling, use an initial temperature of 1500 F. Furthermore, suppose that the temperature leaving the high-pressure turbine would be 1200 F without cooling. Now the cooling air will actually cause a final temperature, after heat transfer and eventual mixing of the streams, somewhat lower than this value. Then by burning fuel, as in a reheat cycle, we could bring the temperature back to 1200 F. But this is just the same as if we had not touched the main stream but had simply brought the cooling air up to 1200 F.

Thus, we have not done anything that would alter the energy relationships of the actual cycle, but we have separated the cooling air and the main gas stream.

We now have two distinct cycles. One of them is a high-temperature, high-compression-ratio cycle, with intercooling. The other has a lower temperature and lower compression ratio and, in general, no intercooling. Each has heat addition at one point, and each has recuperation of heat in the exhaust. Again,

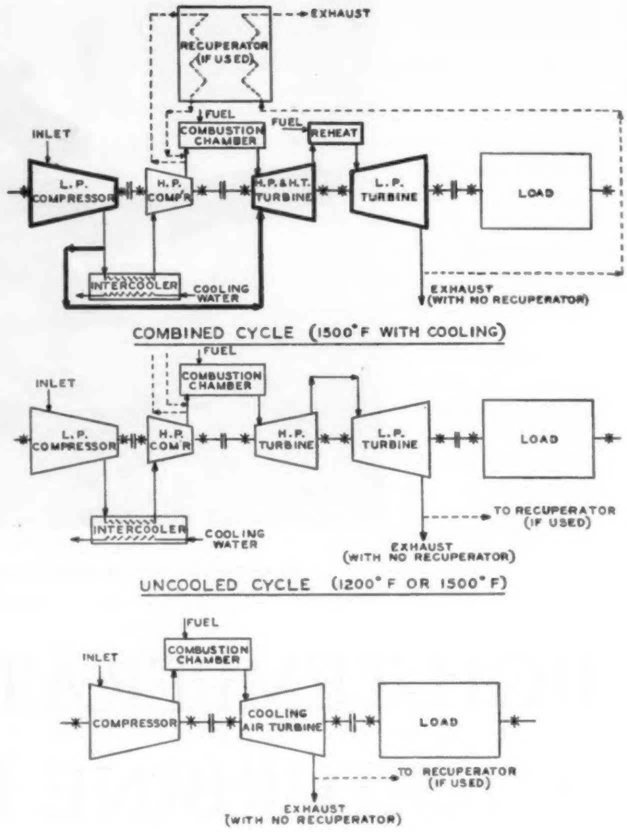

FIG. 1 COOLING-AIR CYCLE

there is a slight difference between the actual cycle and the two hypothetical cycles in that the recuperation actually consists of taking heat from the combined exhaust flow and putting it into the main flow from the high-pressure compressor, whereas the assumed dual system is treated as having two separate recuperations not connected with each other. This, however, in no way alters the over-all energy balance.

EVALUATING THERMAL EFFICIENCY

In evaluating thermal efficiency, we can deal with the sum of the outputs of the two cycles and the sum of the fuel inputs.

The diagram, Fig. 1, indicates the nature of the cycle as it would actually be and as it is here assumed, broken up into two cycles.

The calculations of efficiency have been made under assumptions which will be presented. They differ slightly in several details from the assumptions made by other authors but, comparing the results for the uncooled cycle, quite close agreement is seen.

The results are presented in Figs. 2 to 5. Curves are given for the uncooled 1200 F and 1500 F cycles and for the 1500 F cycle with cooling, with an assumed cooling-air flow amounting to 10 per cent of the main flow. Experience has shown that perfectly satisfactory operation with 1500 F initial temperature is possible with perhaps 4 per cent cooling air, but it is possible that experience with long periods of full-load operation will indicate the need for 6 to 8 per cent cooling air. At any rate, there is reason to believe that not more than 10 per cent would ever be necessary. The smaller the required amount, the closer the efficiency will come to that for the uncooled 1500 F cycle.

It will be seen that the margin between the 1200 F and 1500 F cycles is appreciable in the case of a simple cycle with no recuperation, but at lower compression ratios this gain is largely sacrificed by the cooling cycle. In the cases of 50 per cent and 75 per cent recuperation (Figs. 3 and 4, respectively), however,

a rather impressive difference is seen, most of which is realized by the cooling cycle. Specifically, at a pressure ratio of 6, which gives an efficiency at or near the maximum, the curves show that raising the temperature from 1200 F to 1500 F would raise the cycle efficiency by 20 per cent for 50 per cent recuperation, and by 24 per cent for 75 per cent recuperation, of which only a small part is spent on the cooling process, leaving a net gain of 15 and 19 per cent, respectively. (Percentage of recuperation, incidentally, refers to the ratio of heat transferred from turbine-exhaust gas to compressor-discharge air, to that which would be transferred with a perfect heat exchanger, having infinite surface and no pressure loss.)

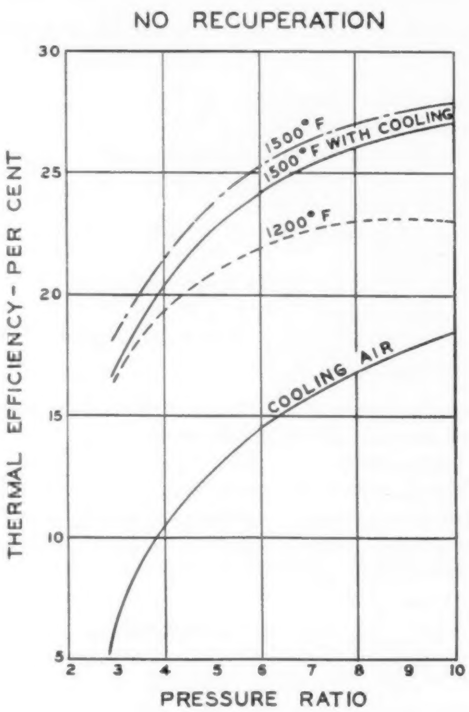

FIG. 2 THERMAL EFFICIENCY, NO RECUPERATION

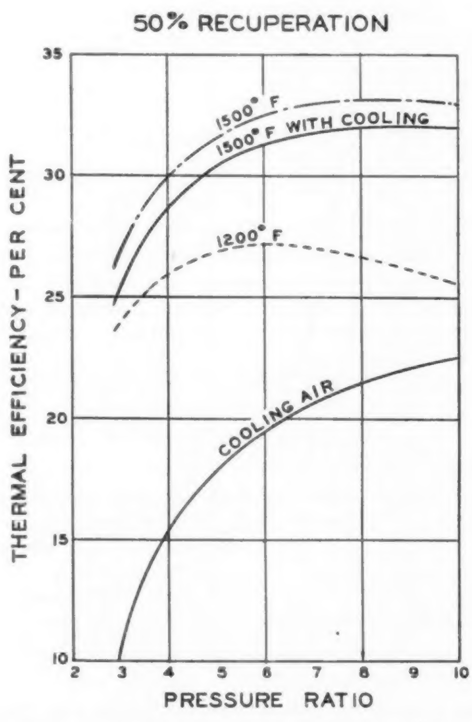

FIG. 3 THERMAL EFFICIENCY, WITH 50 PER CENT RECUPERATION

The curves also show that the optimum pressure ratio for the cooled cycle is the same as that for the uncooled 1500 F cycle, this point being rather different from the corresponding point for the 1200 F cycle. The lower temperature always favors a lower pressure ratio.

The values of efficiency for the cooling-air cycle are also included. These are plotted against values of pressure ratio for the main cycle, rather than for the cooling-air cycle itself, which naturally operates at a lower pressure ratio than the main cycle.

These curves show clearly the reason for the good showing of the 1500 F cycle with cooling. The cooling air itself forms a cycle having some net output and a moderate thermal efficiency, not too far behind that of the uncooled 1200 F cycle. Consequently, the main cycle itself does not suffer greatly from the use of cooling.

The gain of efficiency over the uncooled 1200 F cycle is distinctly worth while. This is particularly gratifying because it can be accomplished with no additional machine elements; the same compressor and turbine are used. Reheating involves some complication, but not of a major character.

OTHER IMPROVEMENTS WITH COOLING

In some respects, even more interesting than the improvement in thermal efficiency resulting from the use of cooling is the gain in the value of the ratio of useful work to the internal work (called work ratio). This is a measure of the bulk and weight of a unit, at least for open cycles, that is, cycles having atmospheric inlet and exhaust. We find that the cycle formed by the cooling air itself has a work ratio almost as good as the uncooled 1500 F cycle, so that the work ratio of the 1500 F cycle with cooling suffers virtually no loss. This is seen in Fig. 5, where the work ratio is given for the 1200 F uncooled cycle and for the 1500 F cycle, with and without cooling. These curves are given only for the cycle with no recuperation, inasmuch as the work ratio is only slightly affected by the degree of recuperation, and the comparative picture is almost totally unaffected.

Another ratio which is of considerable interest in evaluating weight and bulk is the specific net work, that is, the work delivered by the unit for each pound of air flowing through it.

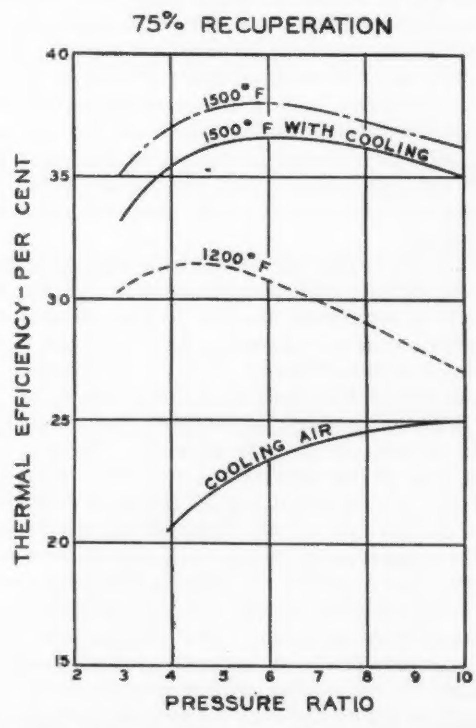

FIG. 4 THERMAL EFFICIENCY WITH 75 PER CENT RECUPERATION

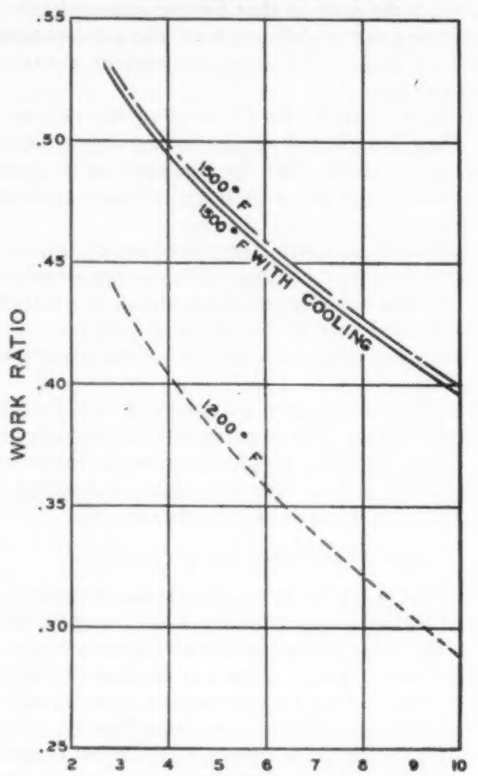

FIG. 5 GAIN IN RATIO OF USEFUL WORK TO INTERNAL WORK WITH AIR COOLING

This is sometimes given as air rate, that is, the flow of air in pounds per horsepower-hour.

It will be seen from Fig. 6, that the air rate for the 1500 F uncooled cycle is far below that of the 1200 F cycle. The introduction of cooling, however, penalizes the low-pressure ratios. Inasmuch as these are not in any case very useful, in that they correspond to low efficiency, this is not serious. At the intermediate and high pressure ratios, the penalty is slight.

Thus, at a pressure ratio in the neighborhood of 6, the 1500 F cooling cycle is seen to have clear advantages in thermal efficiency, work ratio, and air rate over the 1200 F uncooled cycle. The favorable work ratio and air rate are both indications, slightly different in nature, of the suitability of this cycle for applications where weight and bulk are serious factors, namely, any field of transportation, and particularly aircraft.

A contrast may be drawn between the cooling cycle described here and the use of a high temperature drop in a first impulse stage which, as mentioned, also has been proposed as a means of using high initial temperatures. This, however, is done at the expense of turbine efficiency. In a gas-turbine cycle, this is a dangerous type of loss, since it applies to the whole flow of gas, and since each per cent of efficiency that is lost means a loss of several per cent in cycle efficiency. Furthermore, the work ratio falls at the same time as well as the optimum compression ratio, thereby penalizing the air rate as well.

It is not the intention of the authors to make a comparative study of these two types of 1500 F cycle, since there is probably a wide difference of opinion as to the magnitude of the loss of efficiency which must be accepted in order to make use of an impulse stage without cooling. But to give some basis for comparison, it may be stated that to keep the thermal efficiencies the same for the cooling cycle with even the 10 per cent cooling-air flow and for the uncooled turbine, the high-pressure turbine efficiency must be not more than $3^1/_2$ per cent less than in the cooled turbine, e.g., 85 per cent efficiency in place of the 88 per cent assumed. Even then the work ratio would be slightly less for the uncooled cycle. There is certainly no question that this would be remarkable performance in a high-enthalpy-drop impulse stage.

It must not be supposed that the authors are recommending the use of a cooling cycle for all applications. All that is intended here is to point out that for applications where high thermal efficiency is desirable, and particularly where it must be coupled with light weight, the 1500 F cycle with blade cooling offers some really worth while possibilities.

ASSUMPTIONS MADE FOR CALCULATIONS

For purposes of calculation, the following assumptions are made:

Compressor-inlet temperature, 68 F
Temperature after intercooling, 100 F
Efficiency of low-pressure compressor, 0.84
Efficiency of high-pressure compressor, 0.83
Efficiency of turbine, 0.88
Coefficient of pressure loss in combustion chamber and regenerators, 0.975
Coefficient of pressure loss in intercooler, 0.99
Pressure ratios treated, 3, 4, 5, 6, 8, 10
Turbine-inlet temperatures, 1200 F and 1500 F
Per cent recuperation, 0, 50, 75

A few of these items call for some explanation. The efficiencies quoted are assumed to include mechanical losses and thus are not internal efficiencies. The pressure loss in the combustion chamber is treated as a proportion of the total pressure of the compressor discharge. Strictly speaking, these should have been assumed to have different values with different degrees of recuperation. This study, however, is not intended to

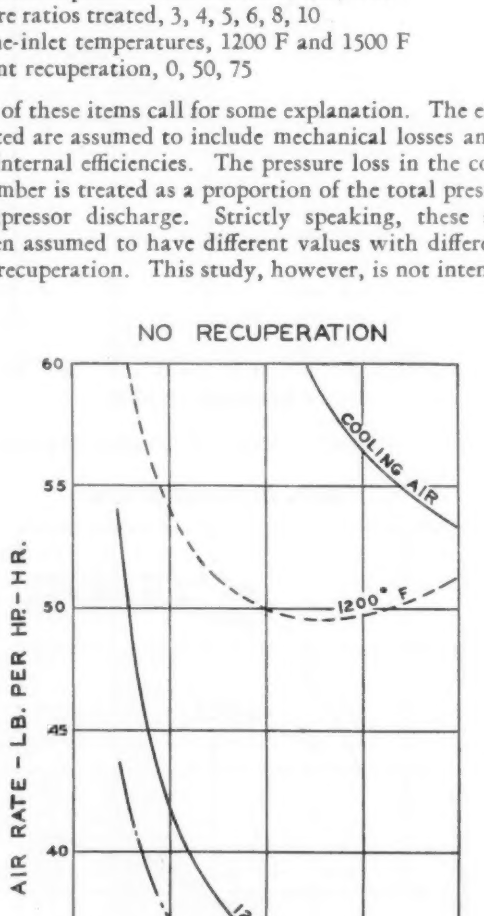

FIG. 6 AIR RATE WITH AND WITHOUT COOLING FOR 1500 F AND 1200 F CYCLES

investigate the merits of more or less recuperation, and the same value was assumed in all cases. The difference in any case is not great.

The pressure loss in the intercooler also is treated as a proportion of the discharge pressure from the low-pressure compressor.

The combustion efficiency of the combustion chamber has been assumed to be 100 per cent with no stratification, i.e., hot and cold layers.

The flow through the turbine has been assumed to be larger than the compressor flow by the weight of fuel burned.

The pressure ratio in the low-pressure compressor was determined in such a manner as to give the minimum work in the compressor. The formula for this, which can be determined by setting up the work equation and equating the derivative to zero, is

$$r_l = \sqrt{\left(\frac{\eta_1}{\eta_2}\frac{K_1}{K_2}\right)^{1/m} R}$$

where r_l is the pressure ratio in the low-pressure compressor, η_1 the efficiency of the low-pressure compressor, η_2 the efficiency of the high-pressure compressor, K_1 the ratio of absolute temperature after intercooling to the absolute temperature at the first-stage inlet, K_2 is the ratio of second-stage inlet pressure to first-stage discharge pressure (the difference being the loss through the intercooler), and m is $\frac{K-1}{K}$, where K is the ratio of the specific heats; R is the over-all pressure ratio.

The pressure ratio of the cooling-air cycle was chosen so that it would give high-pressure air, after the loss incurred in cooling the vanes, having the same pressure as the exhaust gas from the high-pressure turbine would have after expanding without cooling to 1200 F. Thus, the burning of fuel to bring the cooling air up to 1200 F would bring the two streams to the same pressure and temperature so that they could enter the low-pressure turbine as one stream.

Again, it must be emphasized that the purpose of this paper is not to study the absolute value of the efficiency, but only the effects of certain modifications of the cycle. Consequently, the actual values assumed are not of great importance, provided only that they are reasonable and are used consistently. For that reason, reference is made to the close agreement between the results presented in this study for the uncooled 1200 F and 1500 F cycles, and the corresponding results in the paper by Soderberg and Smith (1).[3]

SPECIFIC-HEAT VALUES

Some questions might be raised relative to the proper values to use for the specific heats. For the present study, the old Partington and Shilling values were used, simply because tables of enthalpy drop based upon these values had been in use for some time. In recent years, data based upon spectroscopic determination of specific heat have been made available. Unfortunately, however, among several sources of such data there is some disagreement. Though this disagreement is not great, it is sufficient to lead one to hesitate before throwing out the older values. It might be mentioned that, although the Partington and Shilling specific heats are in error, there is a compensating error in the value of the ratio of the specific heats, which brings the older enthalpy-drop values within the uncertainty of the new data. In several typical cases which were checked, the difference was less than 1 per cent.

Among the numerous sources of specific-heat data are the papers by Sweigert and Beardsley (2), Heck (3), Ellenwood, Kulik, and Gay (4), and Keenan and Kaye (5). All of these may be said to be based upon the same experimental data, mainly the work of Johnston (6). There is, however, a considerable difference of emphasis. Both Heck and Keenan and Kaye give values which are strictly valid only at low pressure, though Keenan and Kaye at least give some evidence, based upon data of Sage and Lacey (7), supporting their procedure. They also present their enthalpy data in a novel form, based upon the so-called relative pressure, which may be helpful in performing certain types of calculations.

Ellenwood and others, on the other hand, indicate that pressure may have an appreciable influence [see discussion of (3)].

In addition to questions concerning the properties of air, some thought should be given to the products of combustion. In the present study, they were treated as having the same properties as air. The differences will not normally be great, but in some cases they can be larger than is desirable. After all, a small error in turbine output may be amplified into a significant error in net output. For instance, although the fuel weight is about 1.7 per cent for the case of 1500 F, pressure ratio of 6, and no recuperation, the difference in net output caused by this small difference is very close to 4 per cent.

Thus, while the actual differences in the results obtained by using these different sets of data and different procedures are not great, they are sufficient to require some real attention. If the old data are to be thrown out, as they should be, they should be replaced by the best available new data. It is a little hard to decide right now what is best. Furthermore, unless everyone in the field adopts the same set of data, there is likely to be confusion. The question of design largely concerns the individual company. Estimating and testing, however, concern the industry as a whole. At the moment, of course, it does not make much difference, but as the gas turbine becomes established commercially, it will become more and more important.

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HIRING HANDICAPPED PEOPLE

A Problem in Human Engineering

By MICHAEL SUPA

INTERNATIONAL BUSINESS MACHINES CORPORATION, NEW YORK, N. Y.

THERE are 23,600,000 individuals who can be classified as handicapped because of some major or minor physical disability; 17,300,000 of these individuals fall within the employable age range. In order to avoid confusion, it is necessary to define accurately the term "physical handicap."

What constitutes a physical handicap? A physical handicap is a physical disability which operates to the disadvantage of the individual by creating for him personal, social, and economic difficulties. These disabilities may be present or sustained at birth; they may be produced by illness or by accident; or they may represent part of the inescapable cost of war.

The severity of the handicap is influenced by many factors of which the more important are as follows:

1 The nature and extent of the physical disability.
2 The age at which the individual sustains his disability.
3 The capacities that remain intact despite the disability.

Proper adjustment to a physical handicap reduces to a minimum the personal, social, and economic difficulties created by the physical disability. The adjustment process is twofold. It involves, on the one hand, the individual's reaction to his disability and, on the other hand, society's response to the physically disabled individual. A consideration of both factors is indispensable to a discussion of the employment of a physically handicapped individual.

THE INDIVIDUAL'S REACTION TO HIS DISABILITY

The success of an individual's personal adjustment to his physical disability will be determined by the attitude adopted by that individual toward his physical defect.

The person with a negative attitude directs an undue amount of attention toward his handicap. He thinks constantly of the limitations his disability imposes upon him. He occupies his mind with thoughts of things which his handicap denies him; for the blind person, it may be the beauties of nature; for the deaf, the warmth of the human voice; while for the crippled, it may be the freedom of going independently where and when he pleases. The person with a negative attitude toward his handicap attributes his failures and his personal shortcomings to his disability. The resulting personality defect is a more significant problem than is the physical defect which created it.

The individual with a positive attitude toward himself and his disability recognizes his disability for what it is. He accepts the limitations which it imposes upon him. He does not devote his time to wondering why he has been so burdened. Instead, he turns his attention toward discovering his remaining capacities. Knowledge of these capacities enables him to expend every effort in their development. Many individuals who have become suddenly disabled have had the opportunity of discovering within themselves a wealth of capabilities which otherwise might have remained latent throughout life.

The disabled person who adopts and maintains a positive attitude toward himself and his disability is rewarded by an emotional stability and a psychological tranquillity that is characteristic of the well-adjusted personality.

Contributed by the Safety Committee and the Management Division and presented at the Annual Meeting, New York, N. Y., Nov. 27–Dec. 1, 1944, of The American Society of Mechanical Engineers.

SOCIETY'S RESPONSE TO THE HANDICAPPED INDIVIDUAL

The disabled person is seeking to achieve his rightful place in society. He desires to share the privileges and responsibilities of his fellow men. He wants to be normal. Unwittingly, society has erected many barriers which have prevented physically handicapped people from attaining this goal. These barriers consist of improper attitudes toward, unwarranted prejudices against, and mistaken beliefs concerning physically handicapped people. These impediments to the social and economic progress of physically handicapped people can be removed only through thorough and continued education of those who possess no physical disability. Society's manner of response to the handicapped individual closely parallels the manner of the individual's reaction to his handicap.

The positive attitude on the personal level can and should be reflected on the social level. The positive social attitude would regard the nature and extent of the physical disability in its true proportions, neither underestimating it nor overemphasizing it. A society with a positive attitude toward its physically handicapped individuals respects the capacities that remain to these individuals and enables them to share in the production as well as the consumption of goods. The ultimate objective of the adjustment process of the physically disabled person is to secure placement within the economic structure of the society to which he belongs. It is at this point that the placement phase of the rehabilitative process and the employment phase of industry coincide.

EMPLOYMENT—THE KEY TO COMPLETE ADJUSTMENT

It is not necessary for every person to be physically perfect in order to be a productive unit in the economic world of today. The person with a physical disability must be employed for his remaining capabilities.

The physically handicapped individual may be employed for his abilities which are identical to those possessed by the nonhandicapped individual. In such cases, the handicapped person is hired to do the same job, and his employment is no different from that of anyone else.

The handicapped individual may be employed for specific capacities which have attained a superior development as a result of his physical disability.

The most effective employment program for the physically handicapped is one that is based upon accurate and complete knowledge of available jobs. The availability of jobs is determined by an analysis of industrial operations in terms of the demands of the job, medical requirements, and safety-department regulations. By comparing carefully the physically handicapped individual's unimpaired abilities with the requirements of the job, it is possible to place the individual effectively and profitably.

There are many physically handicapped people who seek employment. Nonagricultural accidents alone have contributed an average of 70,000 permanently disabled people for each of the years 1941, 1942, and 1943.

Industrial organizations interested in assuming their share of responsibility may come in contact with a few handicapped individuals who apply personally for employment. If no pro-

(*Continued on page 240*)

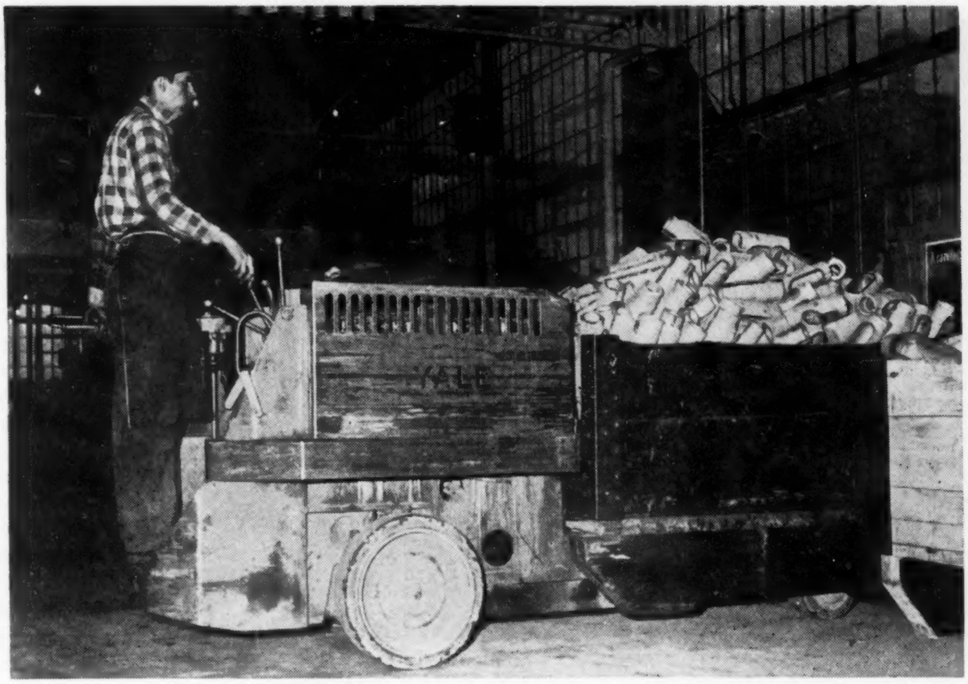


FIG. 1 LOW-LIFT PLATFORM TRUCK OF 6000 LB CAPACITY

MATERIAL-HANDLING AIDS *in* MODERN PRODUCTION

By CARL H. MOELLER

REGIONAL DIRECTOR, THE YALE & TOWNE MANUFACTURING COMPANY, PHILADELPHIA, PA.

THE industrial truck is playing an important role in war production because of its ready ability to pick up and haul heavy loads, to stack one load upon another, to operate in congested areas, to load and unload freight cars, etc., and all at minimum operating cost with a low initial investment when compared with the savings effected.

Manpower shortage has induced the adoption of this method of handling in many places where it had not been applied before. The Army and Navy also placed large orders for this equipment with the result that over 3500 units are produced each month, whereas, in the prewar period, production of the entire truck industry was approximately 100 units per month. At the time this paper was written, manufacturers had orders on their books that would occupy their several capacities at current production rates, from 3 to 6 months ahead.

TYPES OF EQUIPMENT MANUFACTURED

The War Production Board is responsible for some of this increased production, for one reason, because of limitations placed on the truck manufacturers to produce only six types of machines, namely, the load carrier, the low-elevating platform truck, the high-elevating platform truck, the tilting telescopic fork truck, the swinging-boom crane truck, and the towing tractor. Only standard models of these different types received War Production Board approval for manufacture. Furthermore, certain manufacturers were permitted to produce only certain types of trucks; in other words, no one manufacturer was allowed to build the different models of all types.

The so-called "load carrier" model is a machine that has to be loaded and unloaded by hand or by some overhead handling equipment and therefore is the least efficient of the different types of trucks.

The towing tractor is used in conjunction with trailers and is most efficient when the average haul is of 1000 ft or more. These tractors can haul from one to fifteen trailers, depending upon the total load, type of load, width of aisles, and condition of the floors.

The low-elevating platform truck, in conjunction with skid platforms and skid bins, is used most efficiently in hauling material from one manufacturing operation to another, and where the hauls average less than 1000 ft. This machine loads and unloads itself and, through the expert guidance of its operator, can and does handle many tons of material over a 24-hr period. A 6000-lb-capacity model is shown in action in Fig. 1.

Similar use is made of the high-elevating platform truck; that is, it can perform all the operations of a low-elevating platform truck, plus tiering one load upon another, when required, as shown in Fig. 2. This type of truck, when equipped with a power winch, is also used in handling such items as heavy dies into and out of presses and storage racks, Fig. 3.

The swinging-boom crane truck was originally designed and

Contributed by the Materials Handling Division and presented at the Annual Meeting, New York, N. Y., Nov. 27–Dec. 1, 1944, of The American Society of Mechanical Engineers.

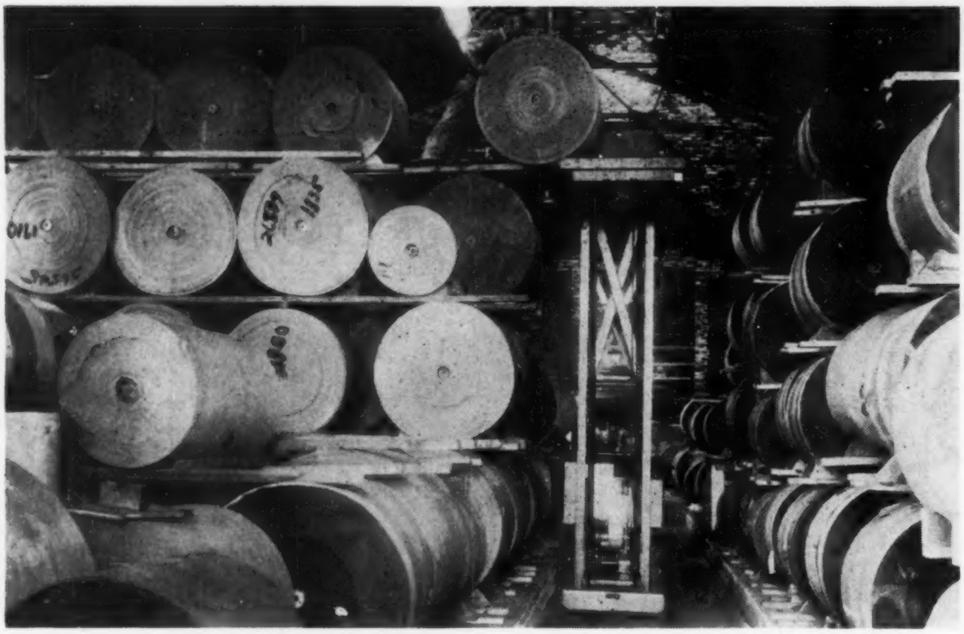


FIG. 2 HIGH-LIFT TRUCK STACKING ROLLS OF PAPER IN STORAGE WAREHOUSE

built for railroad machine shops and engine roundhouse work and of course is still being used most efficiently in that type of service. Subsequently, it was found to be useful in rigger work around manufacturing plants and is used today in actual production work. In many plants, it supplements the overhead traveling crane and, by allocating the lighter types of work to this industrial crane truck, the traveling crane is used only for the heavier lifts. A combination elevating platform and swinging-boom crane truck is now available and is gradually becoming one of the more popular models. This machine is similar to the standard low-elevating platform truck, with a mast and swinging boom mounted behind the elevating platform. It can be operated in and out of boxcars and is used in railroad storehouses and machine shops, Fig. 4.

The most popular model by far, however, is the tilting telescopic fork truck. This machine, like the elevating platform trucks, operates most efficiently in hauls of less than 1000 ft and is used most extensively where it is necessary to tier loads upon one another to conserve floor space, Fig. 5. It is also widely used in loading and unloading boxcars. The Armed Services have developed a method of handling material that has made the fork truck a most essential item in all plans where material handling is involved.

In times past certain types of industrial trucks were built in capacities up to 60,000 lb. During the war, however, Limitation Order L-112, issued by the War Production Board, has limited capacities to 10,000 lb on elevating platform trucks and 12,000 lb on tilting telescopic fork trucks, unless a special directive is issued. The most popular models in both instances, however, are the 4000-lb- and 6000-lb-capacity machines.

DETAILS OF TRUCK EQUIPMENT

All of these models can be procured in what is termed "straight gasoline operation," that is, the truck is equipped with a gasoline engine, transmission, clutch, elevating mechanism, etc., with no electric operation whatever outside of the starting motor. All electric trucks can be equipped with either a storage battery of a kilowatthour capacity that will give satisfactory operation over a 10- to 15-hr period, or a gasoline-engine-driven generator, which unit is installed in the electric truck in place of the storage battery. The user therefore has an opportunity to select one of three different types of power equipment.

All trucks are fitted with rubber tires. Some of the machines have center control, that is, the operator is located in the center of the truck, while others have end control. Many users have found women operators to be quite as efficient, and in some cases more so, than men. Trucks can operate anywhere as long as they have a hard-surfaced aisle or roadway to drive over, and because of this fact, the power-driven industrial truck is the most flexible unit of any of the material-handling aids.

TYPICAL MATERIAL-HANDLING OPERATION FOR NAVY SUBSISTENCE MATERIAL

The fork truck has been mentioned as a most essential tool in the handling of material in the Armed Services. This is par-

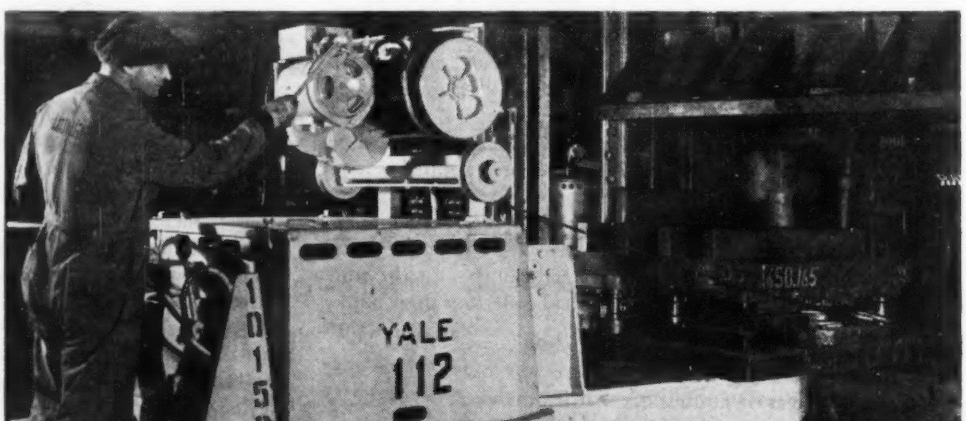


FIG. 3 HIGH-LIFT PLATFORM TRUCK OF 12,000 LB CAPACITY EQUIPPED WITH DOUBLE-DRUM POWER WINCH TRANSPORTING DIES FROM SHELF STORAGE AND HANDLING INTO AND OUT OF PRESSES

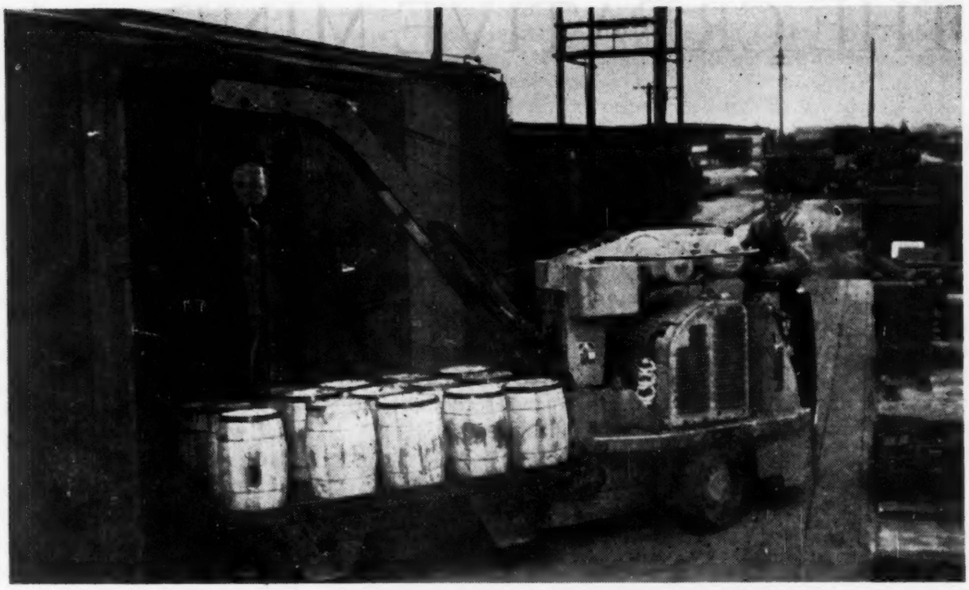


FIG. 4 LOW-LIFT TRUCK OF 6000 LB CAPACITY EQUIPPED WITH 2000-LB-CAPACITY CRANE WITH REMOTE CONTROL

ticularly true of subsistence material, as evidenced by the following outline of a procedure of handling that has been adopted by the United States Navy:

Where a supplier has been awarded a contract for subsistence material, he is requested to ship units upon a pallet measuring 4 ft sq, and to pile the material not more than 4 ft high; also the pallet load is not to exceed 2500 lb. If the supplier is not in a position to ship material in this fashion, he is supplied with pallets by the Navy, which also assists him in procuring delivery of a hand-operated or power-driven fork truck with which he can load the material into boxcars.

From the supplier's plant, it is shipped to some storage depot where it is unloaded with a fork truck and stacked in the warehouse. When ready for overseas shipment, the cases or cartons are steel-taped to the pallet, loaded into boxcars with a fork truck, and hauled to shipside, where the boxcar is unloaded, again with a fork truck, and the material placed in the hold of the ship by means of the ship's crane. There is also a fork truck in the hold of the ship which picks up the pallet load of material and stores it in the hold and between decks.

The fork truck goes along with the ship to its destination, where it is used to unload as well as store the material in some foreign depot or supply dump until such time as it is actually needed by our troops. Then it is again loaded into railroad cars or street trucks, by the fork truck, and hauled direct to the camp.

In other words, not one of these cartons or cases is handled by hand from the time it is placed upon the pallet by the supplier until it is ready for actual use on some foreign front.

It is true that certain large corporations adopted similar methods some time ago for shipping materials between subsidiary plants; also the automobile manufacturers had certain materials shipped to them on pallets or special pallet bins and racks. Paper in sheets has been shipped for some years past on nonreturnable skid platforms, but this system or method of shipping has not been promoted as widely as it should be, in modern production. The return of the pallet has been the biggest objection to its adoption more generally, but in due time a company undoubtedly will be formed which will furnish pallets to shippers on a rental basis and a plan worked out between the shipper and the receiver to cover the cost of rentals.

DEVELOPMENTS IN FORK TRUCKS

The most recent fork-truck development consists of a Diesel-operated machine that is used in the unloading of landing ships on beachheads. This machine eliminates the use of the "human bucket brigade" that was formerly used in the unloading of ships of this type, and which made our soldiers vulnerable to enemy snipers. This fork truck, of course, is designed to operate in and out of water and can negotiate sandy beaches and rough, uneven ground. The air intake and exhaust, the driver's seat, and the load itself are located and carried well above the operating mechanism, and thus the materials are kept fairly dry.

This type of truck will open a new field for material-handling equipment. Where the industrial power truck was mostly used for inside operation, these newer trucks will serve other fields, for example, the construction industry in the handling of building material, such as brick, cement, lumber, steel, and plumbing supplies on pallets.

Considerable attention is also being given to the handling of air-borne cargo with a power-driven fork truck and, in fact, most satisfactory tests have been made by one of the Armed Services in the shipment of material on pallets in cargo planes. These pallets were of course loaded into and out of the plane by power-driven fork trucks and placed in the exact position in the plane by specially built hand-lift trucks. Whether or not this method of handling will be adopted by the commercial air lines will of course depend largely upon the amount of tonnage that will be shipped by airplane in the postwar period.

FIG. 5 TELESCOPIC TILTING FORK TRUCK OF 5000 LB CAPACITY HANDLING AND STACKING PLASTER BOARD

THE CREATIVE MIND *and* VICTORY

By R. E. GILLMOR

PRESIDENT SPERRY GYROSCOPE COMPANY, INC., GREAT NECK, L. I., N. Y.

MY thesis is our country's increasing dependence on its creative minds for victory. By creative minds I mean that relatively small minority with the talent and ability to make new contributions in research, invention, engineering, production, education, and administration in all the sciences and arts. By victory I mean, primarily, the unconditional defeat of our enemies in this war and, secondarily, the survival of our freedom in the world of the future.

THE PROBLEM OF SURVIVAL

Most of us are so far removed from the struggle for existence that we are inclined to take victory and survival for granted. It is useful, therefore, to remind ourselves of the processes by which we have survived—the countless millions of years of evolution of countless millions of forms of life—the countless billions of nonsurvivals and survivals of which we are the beneficiaries. We may refer to the process as the "origin of species" or "natural selection" or "adaptation to environment" or "survival of the fittest." Whatever name we give it, we know that the most basic and inevitable element in the process is conflict. Without conflict life would have stagnated—with it life has progressed to higher and higher forms, finally culminating in man, the highest form ever to have lived on this planet.

It is stating the obvious to say that every form of life is characterized by the means evolved to insure its survival. From the microbe to the elephant, life is replete with the most intricate and amazing individual and social mechanisms to serve this purpose. The survival mechanisms of the insects are particularly interesting; for example, a beetle of the Meloid family which lays its eggs near the burrows of certain mining bees. The eggs hatch tiny lice, the lice seek the flowers frequented by the bees and at precisely the right moment hop on the bee's back and hide in its fur. There they stay until the bee has provisioned her cell with pollen and honey and then, at the moment when the bee lays her egg, the tiny louse jumps from the back of the bee and lands on the egg, which it uses as life raft and larder for several years while it goes through some seven metamorphoses, finally emerging as an adult beetle to start the life cycle all over again. Only once does the tiny louse seek the flowers; only once does it jump on the bee's back; only once does it jump on the egg. Survival requires that some sort of memory cell must continue through all of the transformations and tell the tiny organism precisely what to do and precisely when to do it.

In my company we have a particular admiration for the gyroscopic automatic pilot of the Diptera, or two-winged insects—two tiny alternating gyroscopes, perfectly designed for maximum momentum with minimum weight; a muscular system to drive them; a nervous system to integrate their indications and to differentiate between linear and angular movements; and a wing-control system for automatically executing the orders of the nervous system. This phenomenon is interesting for another reason, in that it has brought about the co-operation of three ordinarily separated scientists—an entomologist of the Museum of Natural History, a histologist of the Presbyterian Medical Center, and an engineer of my company. Someday we hope to catch up with nature on this problem, but we doubt if we will ever be able to keep within nature's specifications for space and weight.

Probably the most mysterious of nature's mechanisms for aerial navigation is that which enables the birds to make long overwater flights—as, for example, from Alaska to the Hawaiian Islands—arriving at precisely the same spot and with perfect timing year after year. Obviously, they have a sense that we do not possess and for which we do not even have a plausible theory.

How infinitely wise the Creator who has linked together the necessarily finite existence of individuals to establish a continuity of life evolving ever and ever to higher forms! And, though we know not how other species feel, we must believe from our own emotions that the zest and joy of survival compensate for all the striving to survive.

CREATIVE MIND CHARACTERISTIC OF MAN

The more we learn of the survival mechanisms of other species, the better becomes our perspective for discussion of the survival mechanism of the genus homo sapiens—us, in other words. We are a recent species with a total existence as the genus homo of probably one or two-hundred-thousand years and with a recorded history as homo sapiens of less than 10,000 years, or less than one one-hundred-thousandth part of the probable duration of terrestial life.

What, then, is the characteristic which has enabled man to become so powerful in so short a time? Our physical equipment isn't very good—we are not very strong; our eyes, ears, and sense of smell are all inferior to many of the animals; we haven't any built-in gyroscopic automatic pilot or folding wings attached to our body. What do we have? The answer is, of course, a mind—or, more accurately, a creative mind.

With that characteristic man has not only survived, not only adapted himself to his environment, but, most extraordinary of all, has succeeded in changing his environment and extending and augmenting his physical powers. Physically equipped only to move slowly on the solid earth, he travels with great speed in the air as well as on and under the sea and over the land. Puny in strength, he has devised the means to destroy most of the species antagonistic to him and has put to his own use many others. He has given himself supernatural powers in the five senses and, with these powers, can hear and see over great distances and through opaque obstacles. Here in this pleasant room the elemental forces with which our remote ancestors contended are so completely excluded that we are hardly aware of them.

With that powerful characteristic, the creative mind, man has invented means to record his experiences so that his knowledge can be passed on from one to the other and so that co-operation in groups is facilitated. He has seen the value of this co-operation and has enormously increased his power by combining in social groups—small at first—but becoming larger until they have taken the form of great nations and international alliances.

Because of his creative mind, ideas have become of paramount importance to him. The evolution of man has become the evolution of his ideas. Nations are based upon ideas, and the same evolutionary pressure which has forced the development of higher and higher forms of individual life has its counterpart in nations which must strive to realize the full inherent possibilities of their composite life.

An address delivered at a dinner in connection with the Conference on War Production and Future Planning, Hotel Commodore, New York, N. Y., Jan. 30, 1945.

Man is by instinct and inheritance an individualist but, to gain the power to contend with his environment, he must to some extent subordinate his individualism to the society in which he lives. Therein lies a conflict. For centuries men have sought to resolve that conflict by evolving a form of society combining individual freedom with voluntary social co-operation. Our country has attained the highest point ever reached in the evolution of that idea. We have produced an unusual number of creative minds. We have the fewest class distinctions. We have the greatest individual freedom and with it a productivity so great that we have difficulty in utilizing it in ordinary times. We wish peace because we cannot gain by war.

In nations where the level of living is low, it has always been possible for ambitious and intelligent leaders to convince the people that if they will subordinate themselves completely to the state their lot can be very much improved. It is this combination of ambitious leaders and frustrated people that has produced most aggressor nations. Maximum national solidarity and military effectiveness is obtained by suppressing all opposition and by completely indoctrinating the people with fanatical ideas of race or religion or other emotional concepts which will unify them. This national unity for aggressive purposes has been accomplished in Germany and Japan to an extent exceeding anything in the experience of the world.

DANGEROUS TO ASSUME PEACE IS PERMANENT

Relatively prosperous and peaceful nations, such as our own, are in the greatest danger when they come to believe that peace is permanent for them, that no nation would wish to make war upon them and that wars are caused by the ambitions of a few individuals. Such was our situation in the twenty years between 1919 and 1939. During all that time the Germans and the Japanese were preparing for war. The Germans, particularly, were aware that war is fought not only for ideas but with ideas—with ideas of organization, with ideas of propaganda, and especially with scientific and engineering ideas for the instrumentalities of war.

In other words, our enemies were aware that the most powerful of all weapons is the creative mind. Since 1935 the very best creative minds in Germany were devoted exclusively to the evolution of ideas for war. As a consequence, the lightning war of 1940 nearly succeeded. It nearly succeeded because their creative minds had developed the ideas for a lightning war—airplanes, tanks, fast ships, radio communication, task forces. It probably would have succeeded if they had taken a little more time to develop the weapons they now have, to accumulate greater reserves of all weapons, and thus had been enabled to strike France, England, and the United States in quick succession.

Even though they did not succeed, the intensive work done by their creative minds put them ahead of us in new weapons and, in many instances, they have been able to stay ahead of us. Their V-2, their tiger tank, their jet planes, their 88-mm gun, and many other of their weapons are very advanced engineering accomplishments. They are still working very hard to keep in advance.

Secretary Forrestal expressed the present situation with completeness and accuracy when he said:

> In principle, what the Germans are trying to do is to buy time through their research, and for their research. Their hope is that one of their groups of scientists will ring the bell with a development which may really change the complexion of the war. In doing so they stand in a triple-threat category: First, because they are good at scientific things; second, because they are unscrupulous; and, third, because they know that they cannot save Germany by ordinary war production.

He goes on to say:

> We should keep in mind that for ten years, and especially since America entered the war, top-flight German minds have been supercharged with the frantic need for major scientific retaliations in the chemical, explosive, and atomic fields as the possible offset to Allied war production. And, as time runs out, the pressure on them, and the danger to us, increases every day.
>
> One of the reasons for the urgency of clinching our victory at the earliest moment arises from the fact that we have not won the war until we win it. We simply cannot be safe from sudden upsets based on scientific research until we stop all Axis war effort of every kind dead in its tracks."

No more penetrating statement has been made. We cannot count on the end of the war until all Axis—German *and* Japanese—war effort of every kind has been stopped dead in its tracks. The German war is not ended, and it is still quite possible that their creative minds may develop the atomic bomb or some other powerful and devilish weapon which might defeat us or force us into a negotiated peace.

And let us not for a moment discount the Japanese. They are fanatic to an unbelievable degree. They call this the "100 Years' War" and mean it. They have large reserves of well-disciplined troops. It is probable that they are receiving every possible assistance from Germany, whose leaders hope that the Japanese can at least bring about a negotiated peace in the Far East, thus retaining a nucleus of power for a future Axis war. And it is a mistake to underestimate the creative minds of the Japanese. They do not have as many as we, but all that they have are intensively engaged in adding to their military strength, and the indications are that they are making rapid progress and are ahead of us in some developments.

Victory in this war will remain uncertain until it is won. But even if we win a complete and decisive victory, we will still have the problem of national survival. We will be the largest nation with individual freedom and a high level of living in a world filled with war-torn, frustrated, "have-not" peoples. The wider dissemination of knowledge by reason of the rapid development of communication and transport will greatly increase the feeling of frustration of many hundreds of millions of people who have heretofore accepted their lot with little protest because they knew of nothing better. New leaders will arise and some, as in the past, will seek war as a means of improving the lot of their people. But the world must have peace so that its people can devote their energies to obtaining a more complete victory over their environment—victory over disease and squalor, victory which will give the spiritual freedom that comes only from economic freedom. How can we have peace? International agreements are desirable, but past experience teaches us that they can be broken with impunity.

BASIS OF UNIVERSAL PEACE

Professor Van Tyne, head of the department of history of the University of Michigan once said: "We will never have universal peace until the strongest army and the strongest navy are in the hands of the most peaceful nation."

The strongest army and navy does not mean the largest. A relatively small army and navy nearly won a lightning war in 1940. Knowledge of all kinds is accumulating with great rapidity all over the world. Progress in the development, manufacture, and use of weapons arises out of progress in all the sciences and arts. In a few years it will be possible for a relatively small force equipped with very superior weapons to wage a successful lightning war against a large but unwary and unprepared nation.

Twice we have learned that lack of preparedness is an incitement to war—*not* a preventive of war. Twice we have been given time to prepare—it is not likely that we will be given that time again. Let us learn from history. Let us be strong. With strength and a desire for peace, we will have peace.

In war and peace the limitation on our military strength as well as our economic strength is established by the number, quality, and effectiveness of our creative minds. Our evolution

to higher forms, both as individuals and as nations, is dependent upon the evolution of the creative mind. Never has it been so necessary for the creative mind to function so effectively on all that is concerned with survival; on invention and research in all the sciences and arts contributing to national security and social and economic progress.

Well, you are entitled to say, this theory of evolution is rather interesting, we have been told about gyroscopes on flies and other bits of natural history, we have been told of the importance of the creative mind which, of course, we already realize, but what can we do about it? My answer is that *you* are creative minds. *You* have the imagination to determine what to do about it; keep your imagination at work all the time on the problems facing you and put first things first. Victory in this war comes first. Never mind if the newspapers say that Germany is finished and that the Russians are about to enter Berlin. We will know that the Germans and the Japanese are finished when they surrender unconditionally and not until then.

Furthermore, my answer is that you are doing something about it. Today's participation of fifteen engineering societies on nine panels has not only stimulated the imagination and brought about an exchange of knowledge on a variety of very important subjects but has been a remarkable demonstration of voluntary co-operation for the good of the country.

I observe that several of the panels were concerned with administrative problems. The creative mind working for progress in the development and application of good administrative principles probably faces more difficulties than those in any other field. He is dealing with an art, not a science; he cannot prove his theories by the reproducible experiment which is the basis of progress in all the sciences; he has few means of measurement at his disposal; he does not even have a common terminology or a common acceptance of basic principles. But all the more reason for unremitting effort in this field; our social progress will always lag behind our scientific progress until we have a wide recognition of good administrative principles.

From such observation as I have had, I would say that the creative mind is likely to be most effective when it has freedom but, at the same time, the opportunity to be stimulated by the co-operative and competitive ideas of other creative minds. That is one reason why I do not believe that the creative mind can function very effectively in Government services, where inherent and unavoidable administrative obstacles get in the way of both freedom and stimulation. Whether that is so or not, we have to use our relatively few creative minds wherever we find them, and the great majority are distributed widely all over the country—in industry, in the universities, and in private laboratories as well as in Government services.

The men and women with highly creative minds are a very small minority. This quality, like many other qualities in nature, follows the law of distribution expressed by the so-called Gaussian, or bell-shaped, curve—there are few who have none of the quality, there are a vast number with a sufficient amount for a great variety of useful purposes, and an exceedingly small number who have the quality highly developed. The welfare of all of us is inextricably linked together; for selfish as well as for altruistic reasons, each of us must accept the responsibility of being our brother's keeper. The creative minds carry an especially heavy responsibility for on them depends our rate of progress toward a better world. Let us all find better ways of recognizing and encouraging them so that they can do more to help us.

HIRING HANDICAPPED PEOPLE

(*Continued from page 234*)

gram has been established for the correct placement of handicapped people, few, if any, physically handicapped applicants will be employed.

Industrial organizations may be able to become acquainted with physically handicapped individuals through the private and governmental agencies that deal with disabled people in the community. These agencies are capable of supplying lists of disabled people together with a description and recommendation of each individual contained in that list.

These organizations have been closely associated with the rehabilitation and placement of handicapped individuals over a period of many years. One of their chief functions is the occupational placement of capable handicapped individuals. For this purpose, the majority of recognized agencies for handicapped people maintain placement agents who themselves have oftentimes made a successful adjustment to the handicap with which the agency deals. By co-operating with such groups, industrial and business firms are not only able to receive the benefit of advice, counsel, and assistance that result from years of experience with many varying disabilities but also to locate jobs by using the most efficient measuring device—a handicapped person himself.

In a few instances, it will be found desirable and profitable to modify industrial operations so that individuals with specific handicaps will be able to perform them. Such modification is worth while if it does not serve to limit permanently the handicapped individual's occupational flexibility.

It is psychologically healthful for the physically handicapped person to be supervised in the same way as are those individuals who have no physical disability. If a physically handicapped person is not performing his work well, he should be the first to have this knowledge. He desires and should receive the same frankness of opinion and treatment accorded his fellow men. Physically handicapped people have been the object of charity for so long a time that special precautions must be taken to eliminate any elements of charitability. A sense of social responsibility for their employment is healthful, but action founded only upon charity may cause the loss of all that has been gained. Proper thinking will insure the employment of capable physically handicapped people not because they are handicapped but in spite of their handicap.

The ultimate aim of the adjustment process is the social participation and economic progress of the physically disabled individual. Hiring the handicapped must be guided by respect for his abilities and not by pity for his disabilities.

The employment of a physically handicapped individual has three specific results:

1 It enables the handicapped person to attain economic self-sufficiency and thereby to assume his rightful place in society.

2 It enables industry to gain a loyal worker whose productivity, through proper placement, equals that of his non-handicapped fellow man.

3 It benefits society by adding to its social and economic wealth and by reducing the obligations of charity and governmental care.

In the past, lack of faith in the abilities of the physically disabled and indifference to their problems have been the greatest barrier to their employment. Now that this barrier of incredulity and indifference is lifted by progressively minded, industrially responsible men, the economic progress of the physically disabled will become as real and as concrete as the products they will help to manufacture.

Mounting Solid CEMENTED-CARBIDE CUTTING BLADES *Mechanically*

By W. L. KENNICOTT

CHIEF ENGINEER, KENNAMETAL, INC., LATROBE, PA.

A recent development in the use of cemented-carbide cutting tools has been the adoption of solid carbide blades, mechanically held in standard or special tool holders. There are several advantages, as follows, of solid cutters over the conventional design involving a carbide tip brazed to a steel shank:

1 The number of regrinds possible on a small-tipped boring tool is very limited because of the size of tip which can be used, whereas a solid carbide boring tool can be ground many times.

2 The steel shank of a small tool, after milling away a portion for the tip, is frequently weaker and certainly less rigid than a solid carbide tool of the same cross section.

3 The use of a mechanically mounted carbide blade or tip for heavy cutting eliminates the possbility of strains caused by the difference in thermal-expansion rates of steel and carbide. On moderate-sized carbide tips the strain set up between tip and shank in a brazed tool is minor in degree, but when very large tips and heavy shanks are brazed strains of major proportions are set up, often resulting in shear of the braze or fracture of the tip during grinding, use, or other thermal change. With mechanically mounted tips, seated on flat surfaces of the shank or toolholder, the carbide may move in relation to the steel during grinding or use, leaving the carbide in an unstressed condition and permitting the user to take advantage of the full strength of the carbide.

4 Grinding is much simpler as the differential-expansion problem is no longer a factor. This is particularly true of large roughing tools which often require considerable "hogging away" of the shank steel, further exaggerating the 2-to-1 ratio of thermal-expansion rates.

Use of solid carbide blades on heavy roughing work has been made possible through improvement in the physical properties of cemented carbide over the last few years. Breaking strengths have been nearly doubled, permitting the overhang of blades beyond the steel seat and the mechanical clamping of various types.

The greatly reduced price of hard carbide has also been a factor in this development. As recently as 1940, carbide was priced at 45 cents per unit, whereas it is now $3^1/_2$ cents on large standard blanks. At the higher price, it was advantageous to mount a small tip on a large steel shank, but with a price reduction of 92 per cent over the 4-year period, it has become practical to use much larger tips, or in many cases solid carbide cutters.

EVOLUTION IN DESIGN OF SOLID CARBIDE TOOLS

The accompanying illustrations show the design development of mechanically held carbide tips or cutters in single-point tools.

The first application of solid carbide tools on a wide scale was in boring tools of round or square section for precision boring and other small-hole boring. These have become standard items and are widely used in sizes up to $^3/_8$ in. sq, Figs. 1 and 2.

The earliest widespread attempt to use solid blades on larger work was in a tool called the "Moore Grip" tool, Fig. 3, which consisted of a steel toolholder mounting a small carbide block. In order to provide a serrated surface on the tip, a thin shim of steel was brazed to the carbide, a design which we know to be unsatisfactory and which made the tool a failure. Subsequent attempts have been made to develop a blade with serrations, but as yet no satisfactory solution has been found. The shrinkage of carbide during sintering prevents forming serrations in the pressed powder state, as any error is cumulative over the number of serrations and a relatively small variation in shrinkage makes the serration unusable. Serrations ground from the solid carbide after sintering are too expensive for widespread application, and use of aluminum bronze, cast iron, mechanite, etc., in shims brazed to the carbide for serrating, has given trouble either because of the shim having sufficient strength to set up thermal strains, or having too little strength and hardness for a durable serration.

The next attempt was on a heavy and rather complicated tool, Fig. 4, mounting an advanceable carbide blade with a carbide-faced mechanical chip curler to protect the steel body from chip erosion. This tool was made under the assumption that a very strong clamping device was necessary to hold the cutting edge in place, and the resultant tool was too clumsy to use on most machines. This tool was also quite expensive.

Investigation of clamping pressures necessary to hold the carbide tip in place in a carefully machined recess brought out the surprising fact that no clamp at all was needed on continuous cutting, once the cut was started. The cutting forces were such that they held the tip against the support on the bottom, side, and end, a clamp being needed only to hold the tip firmly against those surfaces until the cut was started, or during interruptions in the cut. With this situation in mind, a small overhead clamp, Fig. 5, was designed, later simplified to a single-screw design, Fig. 6, which has been standardized upon and used for several years on medium-heavy cuts with great success. Particularly in shell-making shops, where grinding practices were poorer than average, and usage severe, these tools showed up advantageously. In many cases, the life of a tool was increased by two or three times, as a result of the elimination of breakage traceable to thermal cracks in grinding.

The next need which arose was for a tool with no "superstructure" to interfere with flow of heavy chips on feeds of 0.050 in. and over. Such chips do not require a chip breaker but do require more room for flow as they curl to a larger diameter. A tool with internal clamping mechanism was tried, Fig. 7, using a rotary cam against a ledge on the underside of the tip. Under heavy load, however, the hollowed-out shank under the carbide deformed, causing failure of the tool.

A half-round blade of carbide was next used, with a clamping device at the end of the blade, Fig. 8. This provided a solid seat, but it was found difficult to maintain sufficient accuracy of fit between shank and carbide without excessively close grinding tolerances.

Contributed by the Research Committee on Metal Cutting Data and Bibliography and presented at the Annual Meeting, New York, N. Y., Nov. 27–Dec. 1, 1944, of The American Society of Mechanical Engineers.

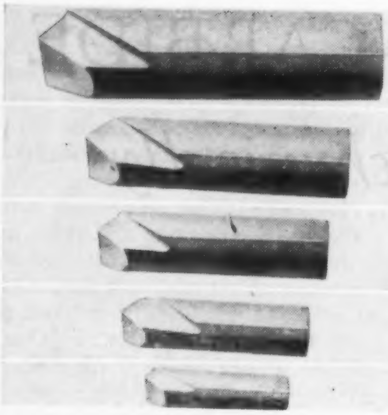


FIG. 1

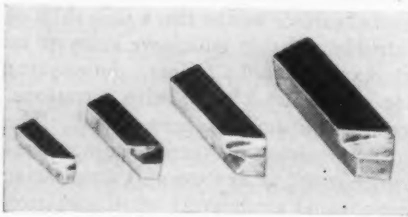


FIG. 2

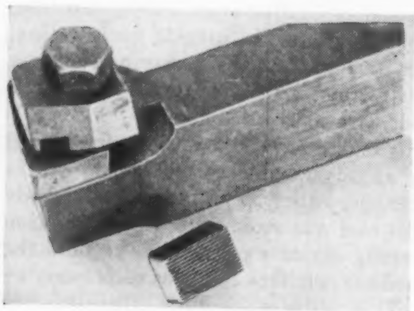


FIG. 3

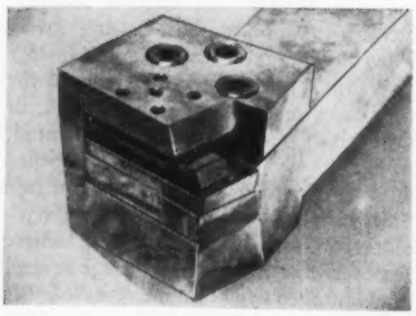


FIG. 4

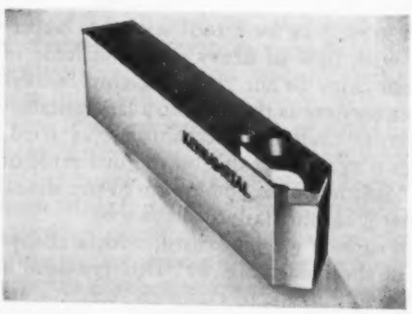


FIG. 5

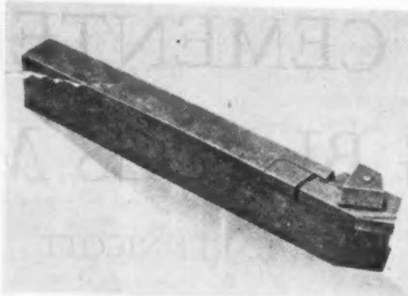


FIG. 6

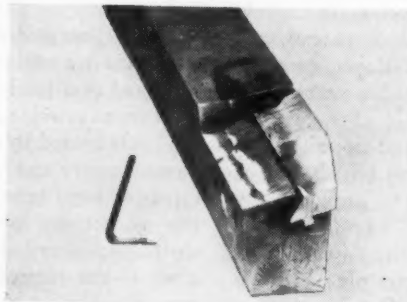


FIG. 7

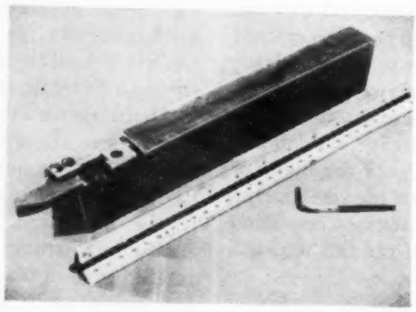


FIG. 8

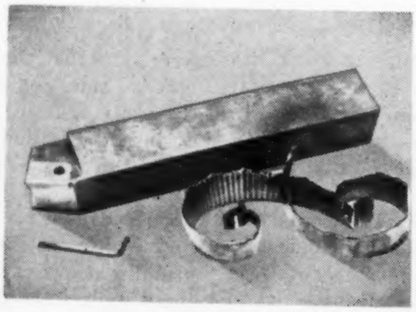


FIG. 9

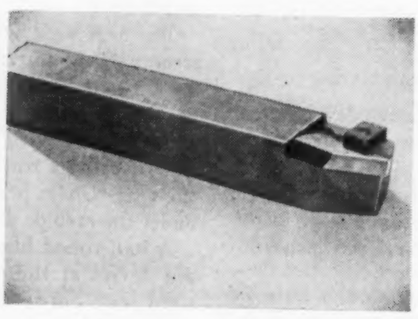


FIG. 10

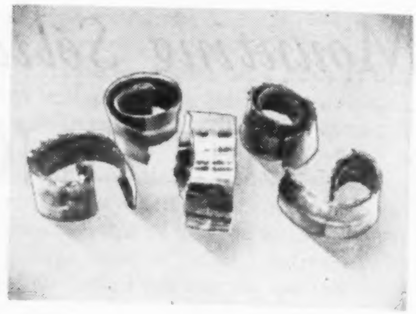


FIG. 11

FIG. 12

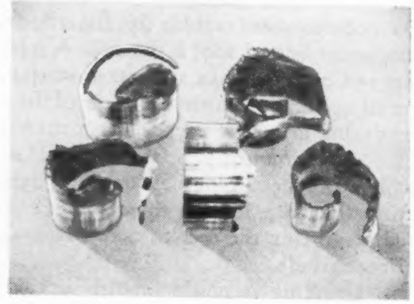


FIG. 13

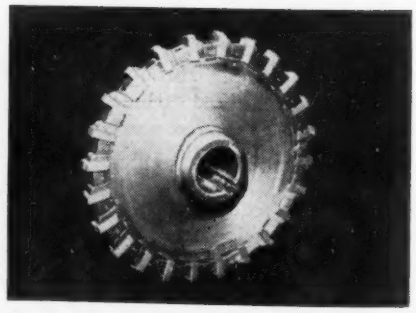


FIG. 15

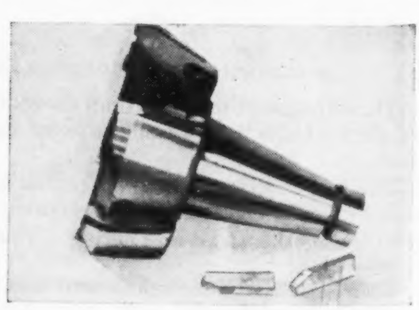


FIG. 16

The next design, Fig. 9, was similar to a conventional brazed tool, except that the tip was formed with a hole and counterbore near the radius corner, permitting the carbide to be fastened down with a recessed-head cap screw. This design has performed very well on both medium and heavy cutting, its chief drawback being that the tip is not advanceable in the shank, and both steel and carbide must be ground to resharpen the tool.

CURRENT DESIGN OF HEAVY-DUTY TOOL

The present design, referred to as the "HD" or heavy-duty tool, Fig. 10, has a small clamp on an angular ledge at the back edge of the carbide. The shank is heat-treated to provide a durable flat seat, and the clamp merely holds the carbide against this seat, the shoulder alongside, and the advancing screw at the back end.

Fig. 11 shows chips made in machining a 25 in. rotor forging at 0.075 in. feed, 110 ft per min, and 1 in. max depth of cut. Similarly, Fig. 12 shows chips from a 20 in. diam nickel steel propeller shaft 248 Brinell, cut at 74 ft per min, $^1/_8$ in. feed, and 1 in. max depth (75 cu in per min or 22.2 lb per min removal). Fig. 13 shows chips from rudder stock forging, $1^1/_8$ in. max depth of cut at 110 ft per min, 0.078 in. feed, interrupted cut.

This heavy roughing work on large parts is a relatively new field for carbides, opened up through the use of mechanically held carbide cutting blades. While the same jobs can theoretically be done with conventional brazed tools by stepping up the speed and cutting down on feed, the machines on which such jobs are turned will not usually turn fast enough. Even on specially built machines, large irregular castings or forgings cannot be rotated rapidly due to out of balance. Centers become a problem on such large work also and can handle the large weights more easily with lower revolutions. Use of heavier feed eliminates the need for chip breakers, increasing the rate of removal for a given available horsepower.

The cutting speeds and feeds used with these HD tools on heavy work are shown roughly, in Table 1.

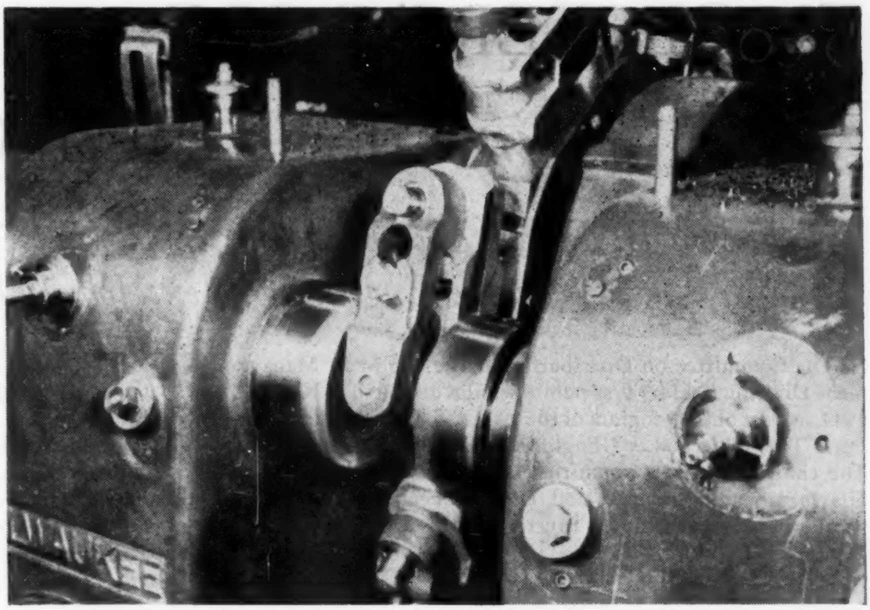


FIG. 17

TABLE 1

Material	Speed, fpm
Chrome-nickel-moly (forged)	40–75
S.A.E. 1045 (forged)	90–175
S.A.E. 2340 (forged)	60–150
Armor plate (cast or forged)	60–150
Cut	**Feed per rev, in. (max)**
With cuts $^1/_4$ in. and under	$^1/_4$
With cuts $^5/_{16}$ in. and over	$^1/_8$

Horsepower is the limiting factor in most cases.

Use of solid carbide blades in double-negative-rake milling has resulted in particularly outstanding results. This is not due to the fact that a solid carbide cutting blade, mounted in a milling cutter, is any better than one mounted in a single-point tool, but rather that a brazed multiple-point tool has more strains than a brazed single-point tool. In large milling cutters, the proportion of carbide to body is less favorable than in a single-point tool, and the milling cutter must be heated repeatedly in brazing instead of only once. Hence a solid-blade milling-cutter design provides a more dependable performance, equaling with consistency the best runs experienced with a brazed cutter.

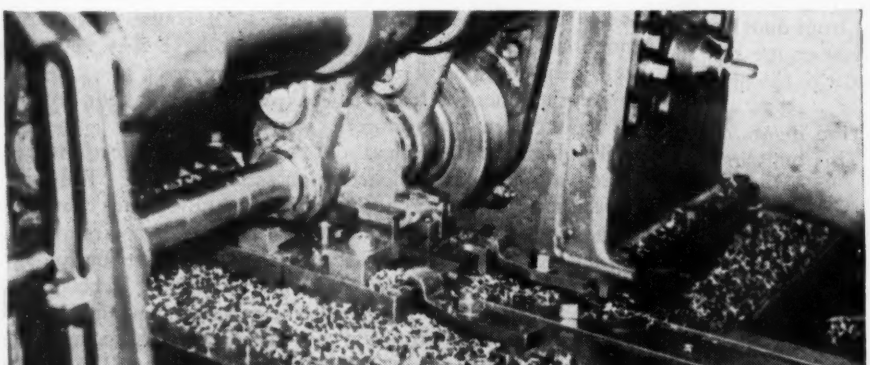


FIG. 14

APPLICATION OF SOLID-BLADE MILLING-CUTTER DESIGN

The first production application of this was on a slotting operation in an aircraft-wing hinge, Fig. 14. The cut was slightly over $^1/_2$ in. wide, the hinge from $^3/_4$ to $1^1/_2$ in. thick, slotted completely through for about 9 in. of the length. Prior to conversion, a high-speed-steel cutter was being used at 25 rpm, $^1/_2$-ipm feed, with a floor-to-floor time of 24 min. This was replaced in October, 1943, with a carbide-tipped slotting cutter of brazed construction, run at 224 rpm and $10^1/_2$-ipm feed with a reduction in floor-to-floor time from 24 min to 4 min; actual cutting time from 20 min to 55 sec. These results were certainly encouraging, typical of many

(Continued on page 254)

ENGINEERS' ROLE *in* DISTRIBUTION

Fenton B. Turck, Morehead Patterson, and Gano Dunn Comment on the Engineers' Next Job in Industry

[The Committee on Distribution of the A.S.M.E. Management Division held its first public session on Tuesday Nov. 28, 1944, as part of the program of the 1944 A.S.M.E. Annual Meeting. The subject was "Engineer's Next Job in Industry." The chairman of the committee, Fenton B. Turck, presided. His introductory remarks and the comments of two of the speakers have been brought together in this article.—EDITOR.]

COMMENT BY FENTON B. TURCK[1]

IT IS generally agreed that engineers, using engineering methods, have been responsible for the wartime "miracle of production." To engineers this has been no miracle—just a lot of hard work, much of which was done decades ago in convincing management that engineering methods would increase production and dividends. In case after case management applied engineering techniques to production until it had invested billions of dollars in equipment, plants, and methods. The result was the great American production capacity which is performing the "miracle of production" for the democracies of the world during the war.

American industrial management now faces an opportunity to perform another miracle, this time in the field of distribution. Once again men of engineering training must be set to work. Once again the engineering method must be employed. Once again billions of dollars must be invested. Once again unit costs will be driven down; and with efficiency in distribution added to efficiency in production, our national economy should be on a sounder basis than ever before in our history.

WHAT DO WE MEAN BY DISTRIBUTION?

Distribution is a far more significant portion of our economy than is generally realized. A ton of coal at the mine is only a matter of miles from our cellar; the shipping platform of a factory is only just around the corner from our front door. Why then, has distribution—the link between you or me and the mine or factory—become such a complex factor to the producer as well as the consumer?

The dictionary does not contain a definition involving the many different functions of distribution. This omission perhaps justifies an interpretation.

Distribution is the total of all activities involved in the progression of goods from the producer to the consumer. It includes warehousing, transportation, wholesale and retail marketing, advertising, and a substantial part of research, engineering, accounting, and financing.

Like a fine watch, distribution is simple when you glance at its face and extremely complex when you examine its works.

Frederick W. Taylor pioneered modern production by first applying the engineering method to production with the simplest tool—the shovel. He found that a shovel with a capacity of 21 pounds gave maximum production with minimum fatigue. For each link in our system of distribution there are tools to be used. These tools have been evaluated. Their worthiness is based on their ability to produce the best and most economical end results. Unfortunately, these proved tools are not in wide use in distribution, but they do exist. They have been found worthy.[2]

What Is Distribution?

Distribution is the total of all activities involved in the progression of goods from the producer to the consumer. It includes warehousing, transportation, wholesale and retail marketing, advertising, and a substantial part of research, engineering, accounting, and financing.

FENTON B. TURCK

Top management is primarily interested in the total result. We cannot advance distribution materially by confining our attention alone to salesmanship, warehousing, transportation, or standards of measurement. There must be a wide application of engineering methods throughout the whole system of distribution if business leadership is to be justified in supporting the adaptation of engineering to distribution. A basic job has to be done by producers and by many independent businessmen, such as the wholesaler, distributor, and retailer. There is a preponderance of small units in these fields. Engineering methods must be available to these small units as well as the large corporations. Only then will the standard of living of each of us benefit from the work of engineers in the field of distribution.

Many ask a pertinent question: "Has not a great deal already been done in distribution?" Of course distribution methods are continually advancing, but have they kept pace with expanding markets and the public need?

Another question frequently asked is: "Why is the problem of major current importance?"

The justification of an all-out effort for the application of engineering methods to distribution seems obvious. The widespread use of such methods in production now means that more goods and services have to be sold to supply labor with a single productive hour's work in the factory. Our distribution system has before it a great opportunity. Will it generate the orders necessary to keep our efficient factories and trained productive labor at work? From now on we must make an all-out effort for more effective distribution—or else. That means we shall face an alternative. We must choose. On one hand, if we do not improve distribution practice, we shall be forced to cut down the productive output per worker. On the other, through engineering methods we can develop expanded markets, maintain employment, and increase the production per worker. Only if we choose the second can labor, manage-

Contributed by the Management Division and presented at the Annual Meeting, New York, N. Y., Nov. 27–Dec. 1, 1944, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[1] President, Turck, Hill and Co., Inc., New York, N. Y. Member A.S.M.E. Chairman, Committee on Distribution, A.S.M.E. Management Division.

[2] "Scientific Methods of Distribution," by Fenton B. Turck and William E. Hill, MECHANICAL ENGINEERING, March, 1944, pp. 183–191.

ment, and the public jointly benefit in the full use of America's great resources.

COMMENT BY MOREHEAD PATTERSON[3]

OUR topic is "Engineers' Next Job in Industry." You are undoubtedly thinking that engineers have enough trouble keeping up with developments in their own lines in this day of amazing progress without looking for new jobs and should leave distribution to salesmen and salesminded executives. There is much to be said for this view, and surely distribution cannot exist without the sales mind. But, the message that I wish to convey to you is that engineers have a great opportunity to apply their type of thinking and methods of approach to the problems of distribution and that they should, as a group, accept this responsibility. Sales and engineering should team together in distribution, with sales carrying out the policies that have been carefully and thoroughly engineered.

My second message is that management, in general, should change its attitude toward engineering thinking in relation to distribution. The opportunity presented by a forthright acceptance of this responsibility on the part of the engineers should be grasped by management and used to the fullest extent.

From a world point of view, the changes in industrial civilization during the last 40 years have been more significant than the changes of the preceding 4000 years. If we look for the greatest single factor in bringing this about, it was the application of engineering thinking and methods to research, development, production, and to engineering itself. The marvels produced in the first half of this period so obviously improved our way of life that cost was of relatively little importance and prices were not the determining factor in sales. In short, there was so much "margin for improvement" that a sufficient demand existed even at high prices.

About 1920, the enormous opportunities for broadening the unit market by cutting production costs and lowering prices became apparent. Engineering thinking and techniques were applied to the reduction of production costs. Volume mounted as prices declined. The phrase, "mass production," became familiar to all. The efforts to reduce production costs have not been confined to large-volume industry. Managements throughout the country have been highly conscious of the necessity for reducing production costs. They have applied engineering methods and techniques on a broad scale. They have given their chief attention to this phase of the business. The watchword has been "the boss is out in the shop."

These intense efforts have given the great mass of people of this country a standard of living far higher than has ever existed here or elsewhere in history. If industry is to live up to its postwar responsibility, it is faced with extending these advantages to a much greater proportion of our population than ever before. That is what the postwar economy demands.

Industry is faced with the law of diminishing returns. The preoccupation of management with the cutting of production costs and improvement of production methods has drastically reduced the "margin for improvement" in these categories. There will be great new inventions in the postwar years, but their production will start with "built-in" mass production and low production costs. If our economy demands that a great extension of our standard of living be made, we must look to other cost factors for the savings which will make this possible.

Obviously, these will be found in the field of distribution, where unit costs have been constantly mounting, as the manufacturing base costs decline. Here I want to emphasize that I am speaking in all cases of unit costs. The over-all money spent on distribution must be greater, postwar, than ever before, but this can only be sustained if unit costs are substantially cut.

My favorite cost-reduction story is that of a household-appliance company, selling 250,000 units per year. (That is semimass production.) The company received an additional tax bill for $250,000 one year. Their product retailed for $95. Its factory cost was $15, leaving $80 for general overhead, profit, and distribution. The management turned to the engineering department for help and asked them to redesign one dollar out of the $15 factory cost. This was a normal management reaction and the engineering department went forward successfully and made up the $250,000. It does not seem to have occurred to the management that the same amount of engineering effort applied to the $80 of costs other than manufacturing might have produced a saving several times as great.

In the past, management has turned to the engineering and production departments for cost reduction, because their costs are relatively definite and ascertainable and cost-reduction methods are well established. In selling, marketing, and distribution, cost-reduction opportunities have been less tangible. Distribution accounting has not been as precise and opportunities for savings have not been so easily demonstrated. These conditions still prevail today. Management, in general, is still "out in the shop."

There will be two dissents from my suggestions; first, research directors and chief engineers of the nation, "Don't we have enough trouble finding good engineers for our departments, without your telling them to become salesmen instead?" They have my sympathy.

Second, there will be the composite protest of embattled sales managers, "You don't want us to use those engineering fellows for salesmen, do you?"

My answer to both is, NO!

I am *not* suggesting that engineering graduates dodge the grueling five years of their postgraduate apprenticeship by becoming salesmen. I am *not* belaboring the importance of salesmen having a thorough knowledge of the mechanical functions of their products. That seems to me to be a recognized and elementary *must*. I am *not* advocating sales engineers on the road as against high-powered salesmen. Management should long since have solved that question of sales-department requirements as applied to their own businesses.

I *am* insisting upon the necessity for the application of engineering thinking—the objective fact finding, accounting, and analysis; the experimentation, testing, and evaluation; and the final establishment of principle and policy that is characteristic of the best modern engineering practice to the problems of distribution.

The greatest part of retail unit cost, today, is in distribution.

Cost reduction to a sales manager sounds like decreased sales effort. Of course, this cannot be our postwar policy. To the engineer, distribution-cost reduction means increased sales efficiency. It is logical that complete engineering studies of the unit cost of distribution will reveal great opportunities for increasing efficiency.

Who can do this better than the well-trained engineer? Is it not essential that engineers should be prepared to accept this responsibility and that management should be prepared to give them every support and opportunity?

The sales mind is a marvelous thing in action. It is quick, clever, and adaptable. It has quick perceptions of psychology and flashes of personality domination. But can it evaluate, account, and develop policy? I do not wish to insult the great sales executives of this country by answering that question, but I know that every outstanding sales executive relies for his basic information, analyses, and planning on outstanding engineering help.

[3] Chairman of the Board, American Machine and Foundry Co., Inc., New York, N. Y.

AN OPPORTUNITY FOR MANAGEMENT

The great opportunity which is presented to management today is the application of engineering thinking and techniques to unit cost reduction in distribution. I don't say that many managements haven't done this already, any more than I allege that all engineers do engineering thinking.

There has been a great reluctance on the part of engineers to broaden their responsibility in sales and distribution. Many engineers say to management, "Tell us what you want and we will develop it for you." That is not good enough. Engineers should be on the firing line at all times, searching for new opportunities and new efficiencies. Now all too often, they leave that to the sales department; and the sales department, in its extravert efforts, are reluctant to be trammeled with policies formulated by the engineering mind.

The problem, therefore, is not a departmental problem. It is a problem for management, for top management's co-ordination of these two functions. Engineers must be ready to accept the responsibility and to prove to management that they are the logical group to take the job.

Where you see the fine uniting of sales and engineering techniques that you do in our most progressive companies, you will find the unit cost of distribution coming down just as production costs have done in the past. This is the new challenge and opportunity to industrial management as it faces the great task of the postwar period.

COMMENT BY GANO DUNN[4]

I BELIEVE that engineering principles can be increasingly applied with remarkable results in the field of the social sciences, which cover a large part of the art of distribution.

The public associates the term "engineer" with inanimate things, such as roads, bridges, machinery, electricity, and chemicals; because those are the things, in the order named, with which engineers have concerned themselves as the profession has grown and played an increasing role in the activities of civilization.

There are further fields which are gradually feeling the effects of engineering influence. These newer fields are in the realm of human relations, covered by the social sciences or, to come down more specifically to the subject of tonight, the field involved in the distribution of commodities.

This field has two branches. One is the mechanics of distribution, such as transportation, warehousing, marketing, advertising, accounting, and financing; and the other, the psychology of distribution. This latter covers the "desire to own," and the great range of human appeals involved in that desire.

The application of engineering to production has worked miracles beyond the expectation of engineers themselves. There the procedure of determination of facts, analysis, experiment, and conclusion, aided by hypotheses supplied by the imagination, has made our country the leading industrial nation of the world.

There are grounds for thinking, however, that development of production has progressed faster than development of the distribution of the products produced. In short, we have progressed farther in the art of manufacture than in the art of selling.

What we are discussing here is whether the application of engineering principles to selling and its associated activities can bring the art of selling abreast of the enormously increased productive capacity of our industries.

In respect to applying engineering to the mechanics of distribution, little need be said because that is already well advanced. But many question whether engineering can be applied to the psychology of the "desire to own." When we enter that field, we enter the social sciences.

I long ago defined engineering as "the art of the economic application of science to social purposes." But science has its gradations. At the head of the list come the mathematical, physical, and biological sciences, which I have been accustomed to refer to as the "hard" sciences. That is because of the exactitude with which they are capable of predicting results. Prediction is the test of a "hard" science.

Further down the list come those other sciences which I call the "soft" sciences, namely, anthropology, psychology, sociology, economics, history, and numerous disciplines associated with them. I call these soft sciences because of their relative inability to predict.

Science, in the English meaning of the word, is not only an ordered body of knowledge, but a method of arriving at new knowledge by observation, analysis, working hypotheses, experiment, and proof.

In this strict sense, the social sciences are not truly sciences. They represent a great body of knowledge more correctly described by the German word for science, *wissenschaft*, but their huge quantity of facts is as yet only partly correlated by laws. It is this that limits their ability to predict with the accuracy of the hard sciences.

But our knowledge of the soft sciences is constantly increasing, rendering them increasingly ready to take their place with sister sciences that were once soft and have now become hard. Astronomy, that right-hand temple column of the hard sciences, was once the soft science of astrology; and chemistry, today one of the prides of the hard scientists, was once alchemy.

As these have moved up in the scale, and as psychology has already moved up a long distance, I believe that sociology and economics are moving up at a rapid rate; and that, even now, enough of their factual material has been subjected to orderly classification to enable the application of engineering principles, with the expectation of increasingly fruitful results in prediction. As a consequence of this, there is developing the ability to make plans with respect to influencing the "desire to own" to an extent that I believe will successfully bring engineering into the field of distribution, with enhancement of the prestige of engineers, increasing opportunities for their employment, and their usefulness to the community.

It is evident that what constitutes an engineer no longer is his occupation, which may run the gamut of the whole range of the hard and soft sciences. What constitutes an engineer is his "way of thinking," which the world is constantly welcoming into new fields.

Engineers have developed for industry an almost unlimited capacity to produce. Yet industry has found no adequate way to move the mass of actual production, much less potential production, economically and continuously to consumers. The operation of the tendency of supply and demand to maintain a balance in our economic activities has been depended upon—but we have applied engineering techniques tremendously to increasing the supply without realizing the extent of our collateral responsibility for applying them to the other side of the balance. . . . . .

Yet economies in production have not been matched by economies in distribution. Industry's capacity to produce has not been fully used because the relatively rigid cost of distribution has blocked the channel—limiting effective demand and so checking the flow of production. The productivity we create demands open channels of distribution. Surely engineering techniques need to be applied there. Our obligation to industry includes the whole process. (From "Engineers of Tomorrow," 1944 A.S.M.E. Presidential Address by Robert M. Gates, MECHANICAL ENGINEERING, January, 1945, p. 6.)

[4] President, J. G. White Engineering Corporation, New York, N. Y. Honorary Member A.S.M.E.

Fabrication Costs of BOILERS, TANKS, *and* PRESSURE VESSELS

As Affected by Width of Plates

By W. G. THEISINGER

ASSISTANT TO VICE-PRESIDENT, LUKENS STEEL COMPANY, COATESVILLE, PA.

BOILERS, pressure vessels, and similar structures may be built of plates formed as illustrated in Figs. 1 and 2. Fig. 1 shows a drum whose length is equal to or greater than its circumference, while Fig. 2 shows a vessel whose circumference is equal to or greater than its length. In either type of assembly, where the shorter dimension does not exceed 195 in. (which is approximately the maximum width of steel plate obtainable) a single plate may be employed. In such case, all the fabricating operations are confined to just one plate, generally of width in excess of 100 in., and as such subject to a "width-extra" charge in addition to the base price.

To avoid width extras, two plates are sometimes used. This practice requires the handling of two plates instead of one, and more than doubles the number of fabricating operations to produce the same shell. To determine whether one-plate or two-plate construction should be employed, the cost of the additional fabricating operations required for the two plates should be compared with the higher initial cost of the one plate due to its width extra.

Vessels are also constructed as shown in Figs. 3 and 4, where the circumference of the vessel is large, and its length is in excess of the greatest width of a single steel plate which can be rolled. In vessels of such construction also, the widths of plates used exert an important influence on fabricating costs to a degree which can be determined by a consideration of the fabrication costs and of the width extras involved.

In addition to the influence of plate width on fabrication costs, there should also be considered its influence on the volume of production and the manpower requirements.

ONE-PLATE AND TWO-PLATE CONSTRUCTION

The number of man-hours required to fabricate a vessel can only be reduced by eliminating or reducing fabricating operations in the shop.

Fig. 5 is a flow sheet, showing the comparison in the number of fabrication operations for the one-piece and two-piece shells shown in Fig. 2. In the two-piece shell, the narrow plates are joined together by means of a circumferential seam in the middle of the length of the vessel. The welding of the extra circumferential seam in the two-plate construction is merely one item in fabricating cost. In addition, all other operations are doubled, such as handling, laying-out, trimming, beveling, heating, crimping the edges, reheating, rolling, assembling, cleaning, chipping, grinding, and X-raying. Further extra operations required for the two-piece type are resquaring and beveling edges for the round seam and rerounding the two courses and their fit-up.

The two-plate type of construction, it will be seen from the flow sheet in Fig. 5, must undergo a total of fifty-three operations, while fabrication of the one-plate type of vessel involves only twenty-three operations.

Contributed by the Metals Engineering Division and presented at the Annual Meeting, New York, N. Y., Nov. 27–Dec. 1, 1944, of The American Society of Mechanical Engineers. Abstracted.

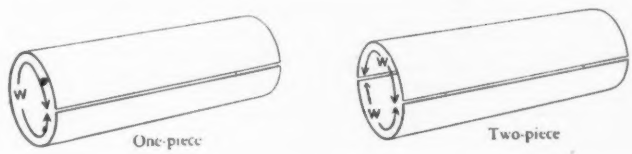


FIG. 1

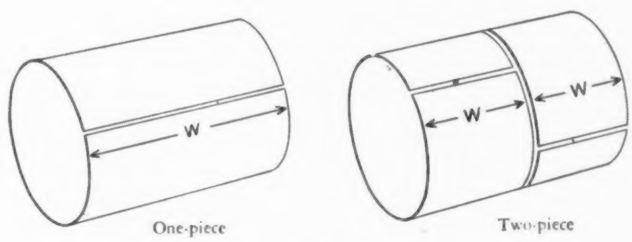


FIG. 2

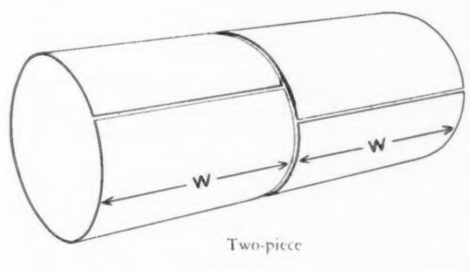


FIG. 3

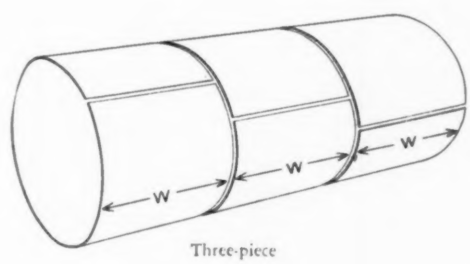
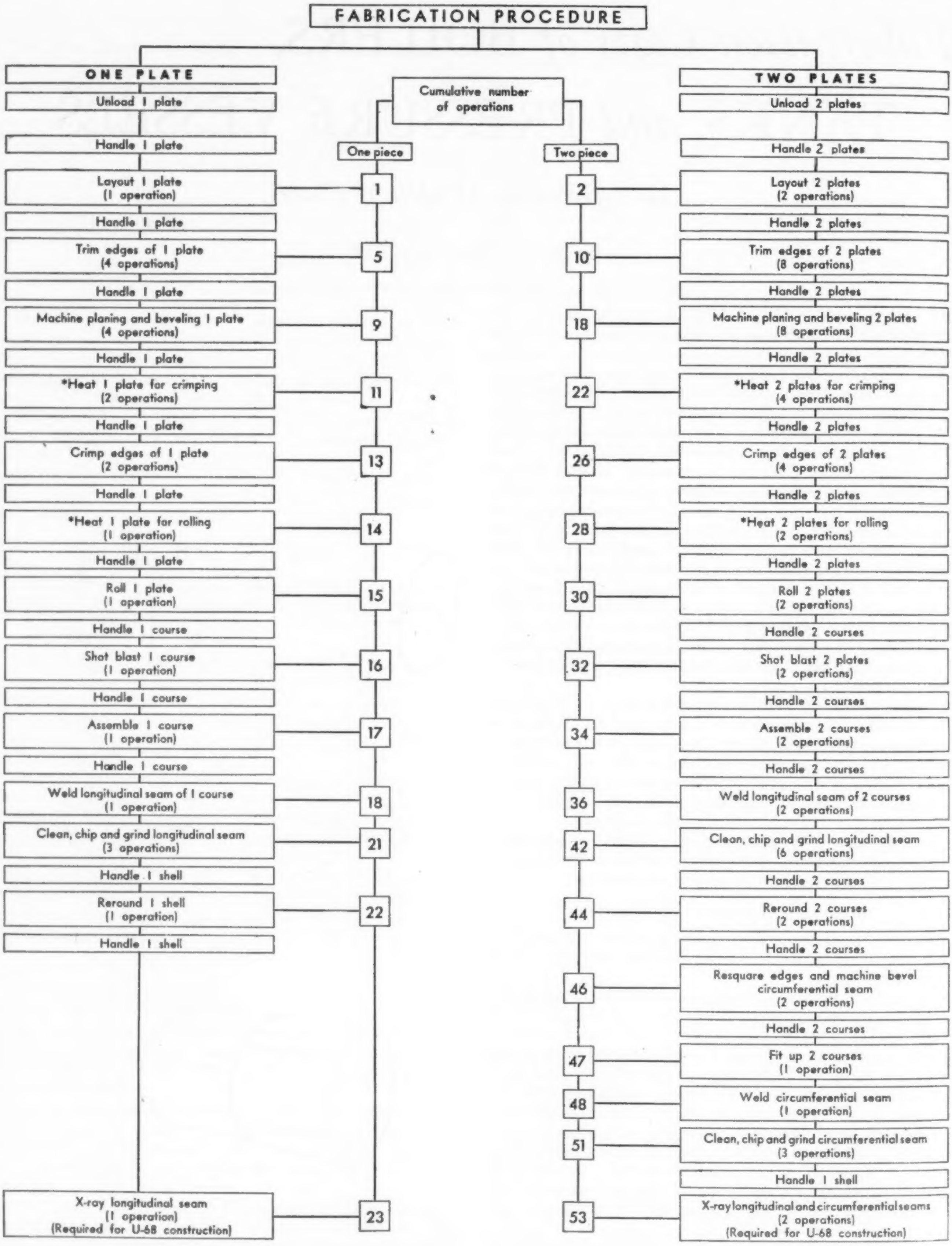


FIG. 4

The reduction of more than 50 per cent in fabricating operations, by the use of the one-piece construction, results in economies in fabricating cost, in fabricating time, and in man-hours required for fabrication. Most important to the fabricator is the possible increase in the plant's productivity, and hence in sales volume, without any expenditure for additional plant or machinery.



* Heating operations not generally required for plates under 1" thick.

FIG. 5

COSTS OF UNNECESSARY FABRICATING OPERATIONS

What are the costs of the additional fabricating operations made necessary by the use of the two-plate type of contruction, as compared with the one-plate type of construction for the structures illustrated in Fig. 2?

To obtain reasonably accurate and reliable data on the cost of U-68 class construction, intensive studies have been conducted over a period of several years. While fabricating costs are known to be higher today, the studies were directed toward determining average costs that would represent a fair cross section of the U-68 type of fabricating industry in normal times. Classes of fabrication other than U-68 can eliminate the cost figures herein on operations which are not employed, such as X-raying which is not required on U-69 work, etc.

Table 1 is a typical example of the costs for the extra operations required in the fabrication of a two-plate vessel, 2 in. thick. For comparison with the entire cost of the extra operations, the percentage relationship of each operation is given. It will be noted that the actual welding of the extra circumferential seam, simply one step in the over-all fabrication picture, costs $5.60 per ft or only about 29.5 per cent of the entire $19.01 which is the cost per ft of seam of the extra fabricating operations required by the two-plate construction. The one-plate vessel, in 2-in. gage, can effect economy in fabrication cost of about $19 per ft of seam, from which saving, the higher initial cost of the one-piece plate, due to the width extra, must be deducted.

TABLE 1 EXTRA FABRICATING COSTS[a] FOR CIRCUMFERENTIAL SEAMS, U-68 CONSTRUCTION; 2-IN-THICK PLATE

Operations	Extra cost[a] per foot of seam	Extra cost, per cent
Layout	$ 0.42	2.21
Trimming	0.60	3.14
Machining	0.92	4.84
Heating and crimping	1.50	7.89
Heating and rolling	2.36	12.41
Shot-blasting	0.22	1.16
Fit-up	0.84	4.42
Extra welding long seam	0.87	4.58
Clean, chip, and grind	0.29	1.53
Reround	0.83	4.37
Resquare and bevel	1.25	6.58
Fit-up	0.83	4.37
Weld circumferential seam	5.60	29.46
Chip and grind	0.72	3.78
X-ray	1.76	9.26
Total	$19.01	100.00

[a] These cost figures include 133 per cent shop burden, but not sales or administrative expense or profit. Shop burdens have been found to vary from 100 to 200 per cent.

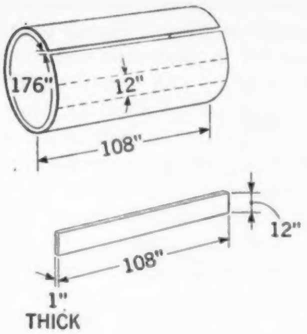


FIG. 6

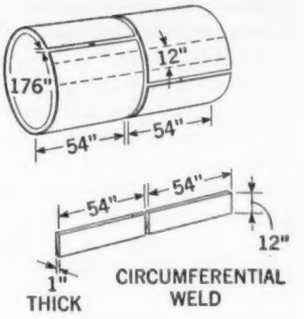


FIG. 7

FABRICATING COSTS AND WIDTH EXTRAS

Width extras for carbon-steel plates are quoted by the mills in cost per 100 lb. The fabricator generally estimates his cost per foot of seam per vessel. Hence it is difficult to compare two dissimilar figures and know, for example, the relationship between a width extra of $0.05 per 100 lb, and a fabricating cost of $11.66 per ft of seam. To overcome this confusion, it is desirable to translate the width extra per 100 lb into width extra per foot of seam or per foot of length of plate.

Figs. 6 and 7 illustrate this common expression in a simple example of a 56-in-diam vessel whose circumference is 176 in. with shell length of 108 in., made from a single plate 1 in. thick, 108 in. wide, and 176 in. long. The theoretical weight

TABLE 2 FABRICATION AND WIDTH-EXTRA COST PER FT PER 100 LB—U-68 CONSTRUCTION

PLATE SIZE, IN.	TOTAL WEIGHT, LB	CIRCUMFERENTIAL WELDING				LONGITUDINAL WELDING			
		COST PER FT		COST PER 100 LB		COST PER FT		COST PER 100 LB	
		Fabrication	Width Extra	Fabrication	Width Extra	Fabrication	Width Extra	Fabrication	Width Extra
12 x 108 x ½	190.9	$ 8.51	$ 0.10	$ 4.46	$ 0.05	$ 6.81	$ 0.10	$ 3.57	$ 0.05
12 x 120 x ½	213.2	8.51	0.32	3.99	0.15	6.81	0.32	3.19	0.15
12 x 132 x ½	236.7	8.51	1.78	3.60	0.75	6.81	1.78	2.88	0.75
12 x 144 x ½	259.5	8.51	2.60	3.28	1.00	6.81	2.60	2.62	1.00
12 x 160 x ½	288.2	8.51	3.60	2.95	1.25	6.81	3.60	2.36	1.25
12 x 174 x ½	316.5	8.51	4.75	2.69	1.50	6.81	4.75	2.15	1.50
12 x 192 x ½	349.2	8.51	6.98	2.44	2.00	6,81	6.98	1.95	2.00
12 x 108 x 1	376.4	11.66	0.19	3.10	0.05	9.33	0.19	2.48	0.05
12 x 120 x 1	420.2	11.66	0.63	2.77	0.15	9.33	0.63	2.22	0.15
12 x 132 x 1	464.5	11.66	3.48	2.51	0.75	9.33	3.48	2.01	0.75
12 x 144 x 1	509.2	11.66	5.09	2.29	1.00	9.33	5.09	1.83	1.00
12 x 160 x 1	565.7	11.66	7.07	2.06	1.25	9.33	7.07	1.65	1.25
12 x 174 x 1	618.2	11.66	9.27	1.89	1.50	9.33	9.27	1.51	1.50
12 x 192 x 1	682.2	11.66	13.64	1.71	2.00	9.33	13.64	1.37	2.00
12 x 108 x 2	752.8	19.01	0.38	2.53	0.05	15.21	0.38	2.02	0.05
12 x 120 x 2	840.5	19.01	1.26	2.26	0.15	15.21	1.26	1.81	0.15
12 x 132 x 2	929.0	19.01	6.97	2.05	0.75	15.21	6.97	1.64	0.75
12 x 144 x 2	1018.4	19.01	10.18	1.87	1.00	15.21	10.18	1.49	1.00
12 x 160 x 2	1131.2	19.01	14.14	1.68	1.25	15.21	14.14	1.34	1.25
12 x 174 x 2	1236.4	19.01	18.55	1.54	1.50	15.21	18.55	1.23	1.50
12 x 192 x 2	1364.4	19.01	27.29	1.39	2.00	15.21	27.29	1.12	2.00

of this plate, including the maximum overweight allowance of 5 per cent, is 385.5 lb per ft of length of the plate. For the width extra of $0.05 per 100 lb for a plate 108 in. wide, the width extra per foot of length of this plate is $0.19. To justify the use of two plates, the fabricator would have to perform all of the extra operations required by the circumferential seam at a cost of $0.19 per linear ft, or less. A good average figure for U-68 fabrication in 1-in-thick steel plate has been found to be $11.66 per linear ft. Thus, using the one-plate shell shown in Fig. 6, the fabricator pays $0.19 additional per linear ft of steel plate, but saves himself a fabricating cost of $11.66 per linear ft, for a net economy of $11.47 per linear ft. As the length of the circumferential seam is 14 ft 8 in., the saving of $11.47 per linear ft becomes $168.22 for the entire shell. The width extra was $1 per ton; the net fabricating cost saved by paying it amounts to $59.50 per ton.

Converting to other units, the fabricating cost of $11.66 per ft becomes $3.025 per 100 lb. By the one-plate construction, the fabricator saves the difference between the width extra of $0.05 per 100 lb and his additional fabricating cost of $3.025 per 100 lb, or a saving of $2.975 per 100 lb, or $59.50 per ton.

As the width of the plate increases, the width extra per 100 lb also increases in steps. A comparison of width extra per ft or per 100 lb with the fabrication cost per ft or per 100 lb will determine the optimum plate width.

In Table 2 are given fabrication costs for U-68 construction, per foot, and per 100 lb, for circumferential welding and longitudinal welding, and the width extras per foot, and per 100 lb, for plate of several gages and widths.

In the case of the plates of $^1/_2$-in. gage in the various widths, it can be seen that the width extras per foot or per 100 lb never equal the fabrication cost per foot or per 100 lb for circumferential welding and, consequently, the wide plate is always justified for the fabricating costs given. For example, with $^1/_2$-in-thick plate 192 in. wide, the width extra per foot in circumferential welding is $6.98, compared with a fabricating cost of $8.51 per ft, or on the per-100-lb basis, the width extra is $2, while the fabricating cost is $2.44.

For a 1-in-thick plate, the width at which width extras and fabrication costs balance is about 185 in.; for a 2-in-thick plate, width extras and fabrication costs balance at about 176 in.

As Table 2 indicates, the thickness of plate must always be considered in determining the optimum plate width, and the calculation for any given gage cannot be applied directly to other gages in the same width. While these fabrication costs are acceptable averages for U-68 construction, they will differ for other grades of construction; the fabricator should compute his own fabrication costs for comparison with width extras to determine the optimum plate width in a given gage, for any grade of construction other than U-68, always being careful to include all items of fabrication costs as shown in the fabrication procedure, Fig. 5.

Fig. 8 shows U-68 fabrication cost per 100 lb converted from the stated fabrication cost per foot, for two-piece construction, and also the width extras per 100 lb. The width extras per 100 lb, charged by the steel-plate industry, are shown in the form of steps for widths over 100 in. Fabrication cost per 100 lb for the two-piece construction by circumferential welding is shown for certain gages from $^1/_2$ in. to 4 in., inclusive. The use of Fig. 8 is illustrated by the following example:

A two-piece construction by circumferential welding of a shell 144 in. long and 1 in. thick would require two plates 72 in. wide. As shown in Fig. 8, on the 1-in-gage curve, fabrication costs $2.30 per 100 lb ($11.66 per ft), while one-piece construction from a plate 144 in. wide would involve a width extra of $1 per 100 lb. The one-piece construction would save $1.30 per 100 lb in fabricating cost, or $26 per ton of steel plate used in making up the shell.

For a $^1/_2$-in-thick shell 132 in. wide constructed from two plates 66 in. wide by circumferential welding, Fig. 8 shows that fabrication would cost $3.60 per 100 lb ($8.51 per ft). One plate 132 in. wide would eliminate the circumferential seam and involve a width-extra cost of $0.75 per 100 lb and result in a saving of $57 per ton in this shell.

The point at which a curve crosses the width-extra line in Fig. 8 indicates the plate width for which the width extra equals fabrication cost. On any curve at any width to the left of the width-extra line, it is more economical to pay the width extra and use one-piece construction. At any width to the right of the width-extra line, it is cheaper to weld two plates to form the shell or cylinder, if manpower is available for the extra shop work and production volume is not a major factor.

Fig. 8 shows, where $^5/_8$-in-thick plates or lighter are used, it is always more economical to pay the width extra and use one-piece construction, while with $^3/_4$-in., 1-in., 3-in., and 4-in-thick plates, one-piece construction is more economical in plate widths up to 185 in., and $1^1/_2$-in., and 2-in. plates up to approximately 180 in. The location of these points varies with the fabrication cost when grades of construction other than U-68 are used.

While Fig. 8 is based upon circumferential welding, it is applicable also to longitudinal welding. As a consequence of the more favorable position in which the welding is performed, the fabrication cost for longitudinal welding is slightly lower, and the curves in Fig. 8 would be somewhat lower for longitudinal welding. Costs for U-68 longitudinal welding, as compared with circumferential welding, are given in Table 2.

To simplify the comparison of width extras and fabrication cost, the width extras have been converted to cost per foot of length of plate as given in Fig. 9. The fabricating costs are shown on the graph by broken horizontal lines at levels corresponding to the values tabulated on the chart for various gages of plate. These costs are based upon the data given earlier. If a fabricating cost differs from the value tabulated, a horizontal

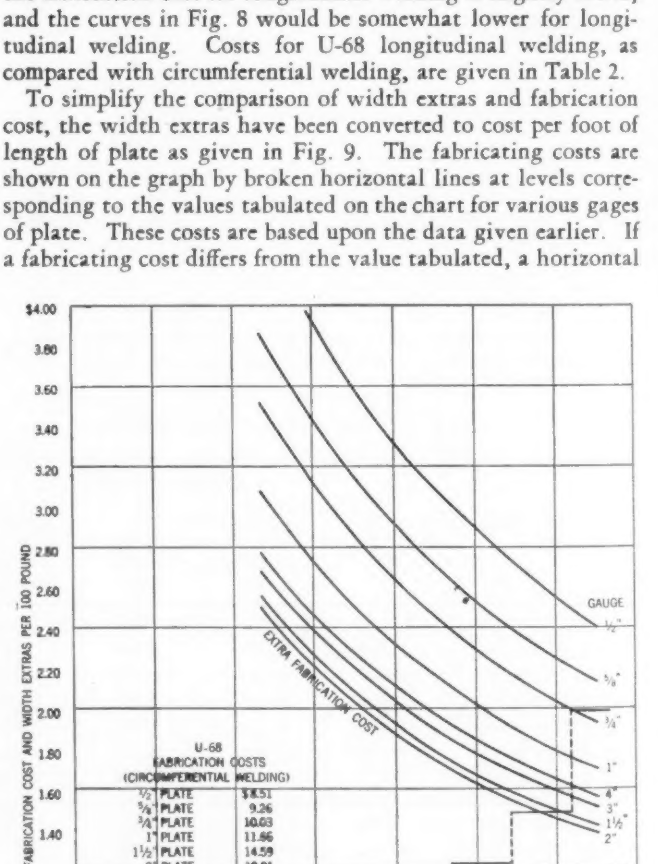


FIG. 8

line should be drawn at a level representing that cost, and the point of intersection with the corresponding width-extra curve should be determined. This point gives the optimum width of plate for that fabricating cost.

With a 1-in. plate having a fabricating cost of \$11.66 per ft, Fig. 9 indicates that the width of plate should be as great as the design permits up to $185^1/_2$ in. With a 2-in. plate, at a fabricating cost of \$19.01 per ft, the cost crosses the 2-in. width-extra curve at a width of 179 in., indicating that the use of any two-plate construction to make up a dimension of less than 179 in. would be more costly than a single-plate construction. A single plate 2 in. thick and 140 in. wide would cost \$7.50 per ft for width extra. If the fabricator elected to weld two plates each 70 in. wide to form the 140-in-wide shell, at a cost of \$19.01 per ft of length, he would be doing so at the loss of \$11.51 per ft of seam. If the length of the plate is in the circumferential direction, and the length of the seam is 30 ft, the excess cost in fabricating the two-piece construction would be \$345.30 for the vessel.

In like manner, a 2-in-thick plate 108 in. wide would involve a cost of \$0.38 per ft of length for the width extra, whereas the fabrication cost for joining two plates each 54 in. wide at \$19.01 per ft of length would result in a loss of \$18.63 per ft of length. This illustrates the necessity of using the greatest possible width of plate that the fabricating cost will permit, if heavy additional fabrication costs are to be avoided.

It will be noted in Fig. 9 that in $^5/_8$-in. gages and lighter, and with the fabrication costs given in the chart, the one-piece construction is cheaper than the cost of fabrication for all widths. In $^3/_4$-in. plate, the one-piece construction is more economical up to 190 in. width, the 1-in. plate up to $185\ ^1/_2$ in., the 2-in. plate up to 177 in., and the 3-in. and 4-in. thicknesses up to 185 in.

Curves for intermediate gages may be plotted as desired in Fig. 9.

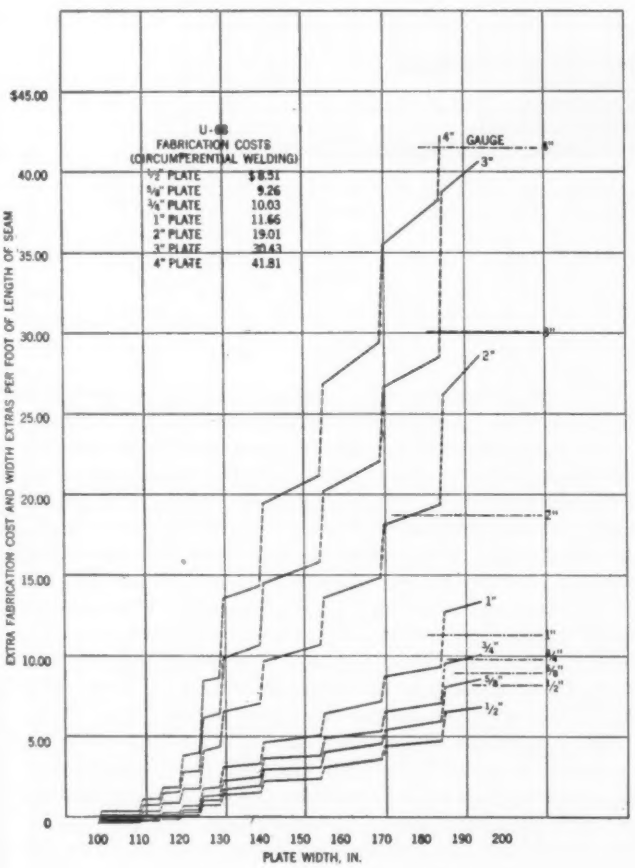


FIG. 9

An analysis of a recent order for twenty 48-in. and twenty 54-in. vessels is enlightening. These shells might have been ordered as follows:

48-in-diameter vessels	54-in-diameter vessels
20 Plates $157\ ^1/_2 \times 87 \times 1^3/_4$ in.	20 Plates $176\ ^3/_4 \times 91 \times 1^{15}/_{16}$ in.
20 Plates $157\ ^1/_2 \times 85 \times 1^3/_4$ in.	20 Plates $176\ ^3/_4 \times 93 \times 1^{15}/_{16}$ in.

After comparison of width extras and fabrication costs, the fabricator placed his order as follows:

48-in-diameter vessels	54-in-diameter vessels
20 Plates $171 \times 157^1/_2 \times 1^3/_4$ in.	20 Plates $183 \times 176^3/_4 \times 1^{15}/_{16}$ in.

With the two-plate construction, the extra fabricating cost, using the fabricator's own figures, was estimated to average \$436 per shell, or a total for the forty vessels of \$17,440. With one-plate construction, the extra for the forty wide plates at width extras of \$1.25 per 100 lb for the $157\ ^1/_2$-in-wide plate and \$1.50 per 100 lb for the $176\ ^3/_4$-in. wide plates, and the overweight allowance, totaled \$9853. By 20 min of calculation, a net saving was effected of \$7587 in the fabrication cost for the forty vessels. In addition, by eliminating the extra fabricating operations which would have been required by two-piece construction, fabricating time on the forty vessels was reduced by 5800 man-hours, or the equivalent of a 48-hour work week of 121 men. There results a corresponding increase in shop productivity without additional expenditure for plant or equipment.

MULTIPLE-COURSE CONSTRUCTION

A similar analysis may be made for a cylindrical vessel in which its length is greater than the widest plate which can be rolled, namely, 195 in. In such a case, the length of the plate, as rolled, forms the circumference of the vessel, and the width of the plate becomes part of the length of the shell. For example, the diameter may be 10 ft and the length 18 to 26 ft. Two-piece and three-piece constructions of such a vessel are shown in Figs. 3 and 4. With three-piece construction, an additional circumferential seam has to be fabricated; the additional fabricating cost is shown in Fig. 10.

A 20-ft-long drum may be made of two courses each 120 in. wide, or three courses each 80 in. wide. The 120-in. plates save the fabricating cost of one seam, and cost a total width extra for the two plates of \$59.30. With three 80-in. plates, 1 in. thick, the cost of making the additional circumferential seam is \$11.66 per ft, or a total of \$380.93. All figures used herein include normal overweight allowances, metal and width extras, involved in the overweight. The wide-plate construction saves the difference between these two costs, or \$321.63 per vessel. In addition 127 man-hours have been saved in fabricating the vessel with wide plates.

With increase in the lengths of the shells, wider plates are required for the two-piece construction, and the width-extra cost may approach the extra fabricating cost for the three seams. However, in each case 127 man-hours of fabricating time are saved on each vessel by the use of the two-plate construction. The maximum width used economically for 1-in-thick plate in the two- or three-course construction is about 155 in. It is uneconomical to use plates under 100 in. wide in any of the combinations.

The economic advantage of wide plates varies with the number of courses used in a vessel. As the number increases beyond three courses, the actual saving in cost, effected through the use of wider plates, becomes less. This results from the fact that the widest possible plates carry high width extras and cost so much that considerable fabrication can be done for less than the width-extra cost. It is nevertheless always true that the use of wider plates reduces the man-hours of labor required for fabrication of the vessel, thereby speeding output and increasing production volume and plant capacity without additional investment in plant or equipment.

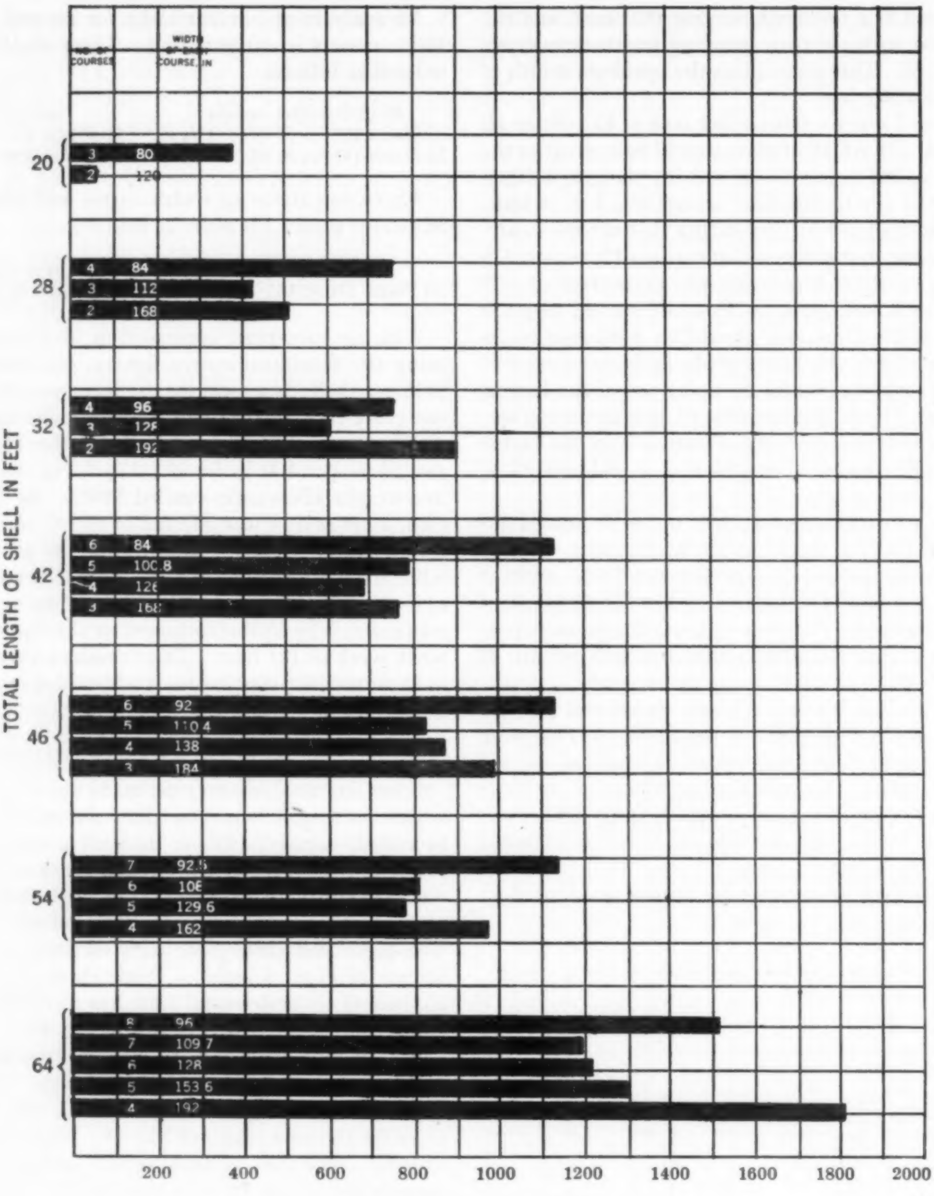


FIG. 10

In Fig. 10, the two vessels 28 ft and 32 ft in length, respectively, may be made up of either two, three, or four courses. The bar charts show the total cost either of width extra or of extra fabrication, or a combination of both. The three-course construction is then seen to be cheapest. An example of the procedure in calculating is as follows:

The 32-ft vessel can be made of two 192-in. courses, three 128-in. courses, or four 96-in. courses. The two-course vessel has a total width-extra cost of \$910.62. The three-course vessel reduces the total width extra to \$243.96, and the extra seam, at \$11.66 per ft for the vessel's 31-ft-8-in. circumference, costs \$369.62, making a total of \$613.58. The three-course construction saves \$297.04 over two courses. In the four-course construction, there is no width extra but two extra seams must be made at a cost of \$762.48. The cost of the four-course construction is greater than for two courses, and much greater than for three courses.

Fig. 10 also shows the cost for shell lengths to 64 ft for a diameter of 120 in. and 1-in. gage. The selection of the optimum construction is not affected by the diameter of the shell since both the total width-extra costs and the circumferential-seam-fabrication costs vary in direct proportion to the diameter.

The most economical width of plate can be seen from these bar charts. For the 54-ft vessel, the five-course construction with 129.6-in. plates, which require an additional circumferential seam as compared with the four-course construction, is lowest in cost. The four-course unit involves a total width extra of \$976.76; the five-course construction costs \$781.27 for width-extra and additional fabricating cost. The six-course vessel involves an extra welding cost of \$739.24, due to the cost of the two additional seams plus \$79.38 for the width extra, for a total of \$818.62. The sum of \$1143.72 for the seven-course unit is the cost of the three extra seams.

These optimum constructions correspond to plate widths between 100 in. and 130 in. Increasing the plate width over 130 in. increases the width extras more than it decreases the fabricating cost. The designer's problem is to find that combination of width extras and fabricating operations which produces the lowest cost of construction.

Fig. 10 also emphasizes the fact that plates less than 100 in.

TABLE 3 MAXIMUM ECONOMICAL WIDTH OF COURSE, INCHES

Number of courses	$^1/_2$-In. plate	1-In. plate	2-In. plate
1 or 2	195	185	176
2 or 3	175	155	140
3 or more	130[a]	130[a]	130[a]

[a] Where the saving in man-hours of fabrication time is important, these widths may be substantially increased.

wide are uneconomical for such a structure. For 1-in. gage where one or two courses are involved, plates up to 185 in. may be used to advantage; where the choice of construction lies between two or three courses, plates up to 155 in. are most economical; where three or more courses are involved, the economical limit is scarcely more than 130 in.

Similar cost data for $^1/_2$-in. and 2-in. gage indicate analogous relationships for vessel construction in these gages.

Table 3 summarizes the results for different thicknesses of plate and number of courses. Every combination should use plates over 100 in. in width for maximum economy.

SAVING MAN-HOURS IN FABRICATION

In long vessels constructed of multiple courses, plates more than 130 in. wide appear to be at a disadvantage if cost figures alone are taken into account. However, the other benefits derived from their use, such as the reduction of man-hours and of the equipment needed for fabrication, may offset the higher cost of wider plates. Consider a cylindrical shell 30 ft long of $^1/_2$-in. gage. It may be made of two plates each 180 in. wide, or three plates 120 in. wide, with an extra weld seam, or four plates 90 in. wide with two extra weld seams. For the two-course shell, the only extra cost is the width extra applicable to 180-in. plates, in this instance totaling $343.66. The three-course shell requires an additional seam costing $268.49 and has a width extra of $51.96 or a total extra cost of $320.45. The three-course shell saves only $23.21 in comparison with the two-course shell but requires 89 more man-hours in fabrication to effect this small economy or two men were employed for a 45-hour week to save $23.21. If these two men had been employed in the production of additional vessels, a greater income would be obtained as a result of the increase in production.

In like manner, the 64-ft-long drum of 1-in-thick plate, shown in Fig. 10, indicates the seven-course combination to be lowest in cost. It is less costly than the six-course vessel by approximately $24 and cheaper than the five-course one by about $109. However, compared with the four-course construction (which is undoubtedly too expensive except under unusual conditions), the extra fabricating time is 123 hours for the five-course unit, 246 hours for the six-course unit, and 369 hours for the seven-course vessel.

The waste of the additional 123 man-hours needed to effect the saving of $24.22 in money by using the seven-course vessel is only outweighed in careless estimating by the saving of $109 at the cost of 246 more man-hours of fabrication time by failing to select the five-course 154-in-wide plates. The estimating engineer should consult his manpower reserve as well as his firm's cash in selecting the right combination of plates in the design of a vessel.

One fabricator, by the use of one 154-in-wide plate instead of two 77-in-wide plates, increased production from 15 to 20 vessels per week, an increase in production of $33^1/_3$ per cent without additional investment in men, machinery, or plant.

OTHER CONSIDERATIONS

Field Inspection of Joints. Where welded joints in vessels have to be inspected in the field after certain periods of operation, wide plates, by reducing the number of seams, keep such service costs at a minimum.

Allowable Overweight of Plates. The "allowable overweight" of steel plates has sometimes been considered as an objection to the use of wide plates. As the width of the plate increases up to 168 in., the allowance for overweight likewise increases. From 168 to 195 in., the percentage overweight allowance remains constant.

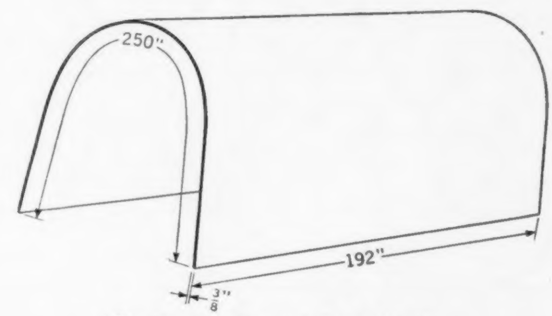
The cost of wide plates is increased by this overweight, but this increase is a small fraction of the savings in fabricating costs and man-hours resulting from the use of wide plates. The following example illustrates this point in a vessel that could be built either of two plates 240 × 144 × $^1/_2$ in., or of three plates 240 × 96 × $^1/_2$ in.

The increased overweight allowance for the two 144-in. plates is $20.54, including the base price, quality extra, and width extra involved as a result of this overweight. This overweight cost plus the width-extra cost for the two 144-in. plates over that of the two 96-in-wide plates is $118.48. The extra fabricating cost plus overweight for the three-course construction is $178.78. The 144-in. plates, despite the greater overweight allowance, show a net saving of $60.30 per vessel.

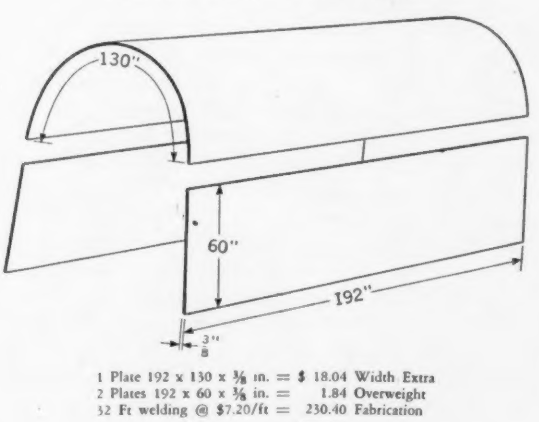
Width Extras and Low-Alloy Steels. The preceding considerations determining optimum plate widths apply equally to plates of low-alloy steel. The width extras for such steels are somewhat higher in proportion to their fabricating costs; the maximum economic width is found to be approximately 10 per cent lower than the carbon steels.

One-Piece Crown-and-Side Construction in Locomotive Fireboxes. Wide plates always result in savings in money, time, and manpower when used in the design of one-piece crown-and-side construction of locomotive fireboxes. The widest and longest plate that can be produced shows definite economic advantage in such structures. In the usual range of sizes, the saving by the use of one-piece construction, as compared with three-plate construction, is about $140 per unit.

The use of a wide plate up to 192 in. wide and 250 in. long requires the handling, rolling, and assembling of one plate only, while the three-piece construction requires the laying-out,



1 Plate 250 x 192 x 3/8 in. = $122.66 Width Extra



1 Plate 192 x 130 x 3/8 in. =	$ 18.04	Width Extra
2 Plates 192 x 60 x 3/8 in. =	1.84	Overweight
32 Ft welding @ $7.20/ft =	230.40	Fabrication
Total	$250.28	
Cost of One-Plate Width Extra	122.66	
Net Saving with One Plate	$127.62	

FIG. 11

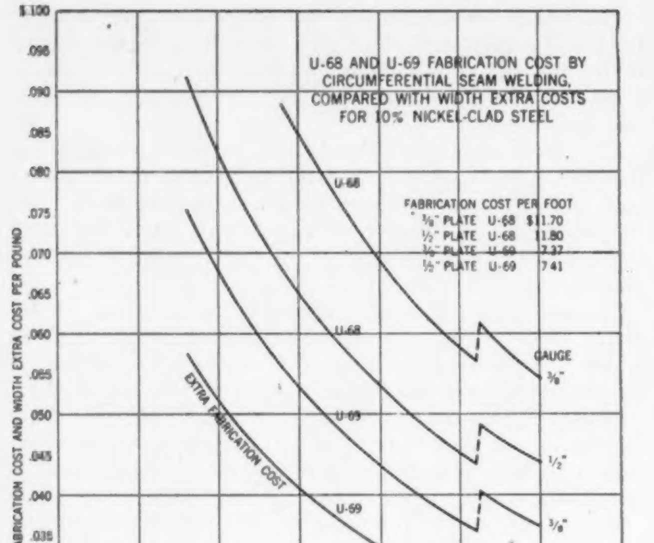


FIG. 12

forming, beveling, and welding of two extra joints. The cost of such work is always in excess of the width extra involved for the wider plate. An example is shown in Fig. 11. The extra fabricating cost, overweight cost, and width-extra cost of the three-piece crown and side is $250.28, while the one-piece unit involves a width-extra of $122.66. The net saving with the one-piece unit is $127.62, or $50.05 per ton of firebox plate. In one-piece crown-and-side construction, the width of the plate generally makes up the length of the firebox, and the length of the plate develops the girth dimension.

PLATE WIDTHS IN CLAD STEELS

The use of wide plates of clad steels shows even greater savings than with the carbon steels, as both the base price of the material and the fabricating costs are higher in proportion to the width extras for the clad steels. The fabricating costs are increased by the care necessary in working the clad materials, and by the cost of the accessory metals such as welding electrodes. With clad steels, the widest possible plate should always be used; all known examples show savings.

A comparison of width extras and welding costs for 10 per cent nickel-clad steel, converted to costs per pound of plate material used, is shown in Fig. 12. For example, with a 1/2-in-gage plate, fabricated in accordance with U-68 requirements at $11.80 per ft, the extra fabricating cost using two 42-in. plates to make up an 84-in. plate by welding would cost $0.078 per lb; a single plate 84 in. wide would cost $0.005 per lb in width extras. This results in a saving of $0.073 per lb or almost one half of the base price of the material, in addition to the other advantages of time and man-hours. As a further illustration, a single plate 108 in. wide would have a width-extra cost of $0.010 per lb, and the fabricating cost to join two 54-in. plates of 1/2-in. gage and built by U-69 construction would cost almost $0.038 per lb. The saving by using the single wide plate would be $0.028 per lb.

Similar curves for stainless-clad steels show that a single plate 108 in. wide can be purchased for a width-extra of $0.015 per lb; two narrow plates, 54 in. wide, of 3/8-in. gage, have a U-69 fabricating cost of $7.37 per ft, and would cost $0.0509 per lb to join together. The use of the wide plate effects a saving of $0.0359 per lb, as well as the savings in shop time and use of equipment.

SOLID STAINLESS AND NONFERROUS METALS

The high-priced solid stainless and nonferrous metals show similar savings for wide plates. A single wide plate 84 in. wide and 1/2-in. gage may be purchased for a width-extra of $0.01 per lb. Two narrow plates each 42 in. wide and welded to form a plate 84 in. wide would cost $0.0469 per lb for the extra fabrication required by U-69 construction at $7.41 per ft. The saving due to wide plates in this case is $0.0369 per lb.

NOTE: Copies of the complete paper, from which the foregoing was abstracted, may be obtained by a written request to the author.

Cemented-Carbide Cutting Blades

(Continued from page 243)

job results with carbide steel milling, yet the cutter life between grinds was so erratic that the operation was almost impractical even at this greatly improved machining time. Runs of 35 per grind were frequent, but so were runs of 2, 7, 4, 25, 3, 16, etc., with no apparent way of estimating what the run would be after sharpening.

A cutter body was designed with radial wedges locking solid carbide blades in position, Fig. 15, and immediately the erratic cutter life became uniform. The previous maximum pieces per grind became the standard practice, and cutters seldom had to be taken out before the 35 pieces had been slotted. In 10 months of operation on this job, the average life between grinds has been 32.3 as compared with 11.2 average previously obtained with high-speed-steel cutters.

After the gratifying results on the slotting operation, the same theory was applied to face mills, Fig. 16, resulting in a design of steel body with solid carbide blades held in place by hardened wedges. The carbide blades are in this case surface-ground or lapped on top and bottom surfaces to maintain flatness and to control the wedge angle.

Radial-design face mills of this type, Fig. 17, were set up on a straddle-milling job in a special drum-type duplex to face opposite surfaces on tractor links, the 8-in-diam cutters running at 200 rpm with 40-ipm feed. With existing loading fixtures, it required three men to keep the machine loaded, so feed was decreased to 34 ipm. At this rate, one man was able to keep up for an hour, but a further reduction to 31 ipm was necessary to avoid overfatigue of the operator. Enough pieces were run at the higher feed rates, however, to ascertain that best operation was at feeds of 34 to 40 ipm, justifying investigation of pneumatic or hydraulic loading fixtures.

These same solid carbide blades are at present being applied to half-side mills, end mills of the larger sizes, slab mills, and special cutters. In all cases the solid-blade design has resulted in more consistant results, when applied to heavy-duty cutters for steel. In general, the advantages of solid carbide blades, mechanically held in position, are as follows:

1 More readily adapted to existing facilities and practices of grinding.

2 Freedom from thermal strains common to brazed cutters from large-area braze, heat of heavy cutting, heat of grinding.

3 More uniform performance on heavy work or multiple-point cutter jobs.

4 Lower tool cost per unit of work completed.

5 Lower initial cost in case of large single-point tools.

As a result of this development, economically and mechanically, we enter a new phase in the use of cemented carbides.

ADVANCES *in* PLASTICS *During* 1944

By G. M. KLINE

NATIONAL BUREAU OF STANDARDS, WASHINGTON, D. C.

THE resources and energies of the plastics industry during 1944 were spent in performing wartime assignments. But the hopes and plans of all were directed toward the challenge of the reconversion market that will follow "V-E" day. Surveys of potential customers of the industry have indicated that a desire to use plastics more extensively than in prewar years exists, but that experience gained in the manufacture of war material has developed a keen appreciation of performance requirements. Forums on potential markets in the merchandise and building fields conducted at the November Conference of the Society of the Plastics Industry (1)[1] gave definite evidence that the plastics industry must adopt simple terminology and recognized standards for its materials in order to gain their fullest acceptance by consumers.

Statistics (2) published during the year indicate that the industry has had a tenfold growth during the past decade. The total production of synthetic resins during 1943 was a record figure of 650,000,000 lb and will probably approach 700,000,000 lb for 1944.

A survey (3) of the materials and machines used in compression, transfer, and injection molding revealed that during the war years 1942–1944 there has been a 44 per cent increase in the number of compression presses, as compared to a 23 per cent increase in thermosetting molding compound. The 165 per cent growth in thermoplastic-molding-powder production since 1941 has been accompanied by an 85 per cent increase in the number of injection and extrusion machines, with the capacity of these new machines far exceeding that of the older and smaller machines. These figures give ample evidence of the ability of the plastics industry to handle the volume of business that will accompany resumption of civilian production. Furthermore, a tally of the molding industry showed that plans have been made for a 20 per cent postwar expansion.

MATERIALS

The panorama of materials development during 1944 is one of steady growth of the already familiar products rather than the introduction of radically new types of compounds. The wartime arrivals announced in last year's review have now fulfilled their early promise and are making important contributions in war matériel. The properties and potentialities of these materials have been much more fully portrayed in articles published during the year 1944.

Polyethylene, which has been in commercial production in this country since 1943, is used practically exclusively for the insulation of high-frequency wire and cable. Several reports (4–8) on its characteristics have indicated that many other important uses may be expected from its combination of flexibility and toughness over a wide range of temperature, low water absorption, and impermeability to moisture, chemical inertness, and excellent electrical properties. These possible applications include containers, gaskets, battery parts, packaging films, chemical equipment, and flexible tubing.

The new class of high polymers called "silicones" has also been the subject of extensive recent reports (9, 10). These organo-silicon oxide polymers include fluids for use over a wide temperature range with little change in viscosity, chemically resistant greases, insulating resins, and high-temperature lubricants. The new high-temperature silicone insulation has made it possible to reduce size and weight of electric motors, to increase greatly the service life of insulation in conventional equipment, and to operate in ambient temperatures and humidities much higher than those permissible for previous types of organic insulation. These resins have provided the basis for the greatest advance in electrical insulation since the advent of glass-fiber tapes and fabrics. Silicones in other forms of more direct interest to the plastics industry are in the laboratory stage.

Plastics engineers are well aware that the 400,000,000-lb plant capacity for the manufacture of styrene, built to meet the requirements of the synthetic-rubber program, represents a tremendous potential source of raw material for the production of polystyrene and styrene co-polymer resins after the war. The forerunners of numerous developments in this field were announced in 1944. The new styrene co-polymer resins (11), known as "Cerex," have A.S.T.M. heat-distortion points ranging from 195 to 300 F, compared with 169 F for polystyrene. Their mechanical properties are fully equivalent to those of polystyrene, and their electrical properties are superior to most thermosetting materials. Cerex is also characterized by low water absorption, excellent chemical resistance, zero plasticizer content, and, perhaps most important of all for a thermoplastic material, dimensional stability under severe service conditions, as indicated by its resistance to boiling water in a 48-hr test. Actual and potential wartime applications for these compounds include coil forms, condenser cases, battery jars and accessories, crystal holders, switch parts, and surgical instruments.

Another new styrene derivative of improved heat resistance is polydichlorostyrene (12, 13), which has been designated as "Styramic HT" by one manufacturer. This material has an A.S.T.M. heat-distortion point of 236 F, and electrical characteristics somewhat better than even polystyrene. Hence it is used for the present in ultra-high-frequency insulating parts in secret war equipment.

Styrene resin has also become available in a new form (14), as extremely fine fibers, ranging in size up to 0.0002 in. diam. This "polyfiber" makes possible low-pressure bag-molding of large thermoplastic polystyrene parts and permits controlled specific-gravity gradients throughout the molding up to 1.05. The material is also of interest for thermal insulation and as a replacement for kapok, in applications requiring buoyancy such as floats, life vests, and emergency rescue equipment.

The vinyl resins continue to expand both in volume of production and versatility of application. The 1944 industry survey showed that present monthly production of plasticized vinyl compounds is in the neighborhood of 15,400,000 lb, which is a 440 per cent increase over the 1941 figure. A new series of vinyl-vinylidene chloride co-polymers (15) was announced under the name "Geon." Resistance to aging, corrosion, solvents, flexing, and abrasion, coupled with the adaptability of the materials to practically all plastic processing techniques, accounts for employment of these vinyl resins in electrical equipment, extruded tubing, screening, gaskets, coated fabrics and papers, packaging films, and molded aircraft and motor-vehicle parts.

A high-solids water dispersion of vinyl-chloride resin (16), known as Geon latex, has been found to be suitable for impregnating paper and fabric and for the manufacture of hospital sheeting and foul-weather clothing. The latex method eliminates costly solvents and solvent-recovery systems and promotes better adhesion of the resin to fibrous bases.

[1] Numbers in parentheses refer to Bibliography at end of paper.

Contributed by the Rubber and Plastics Division and presented at the Annual Meeting, New York, N. Y., Nov. 27–Dec. 1, 1944, of The American Society of Mechanical Engineers.

A somewhat related technique is that utilizing a dispersion of the vinyl resin in a solvent plasticizer or mixture of solvent plasticizers (17). This paste is spread-coated on cloth, dip-coated on forms, or squirted under low pressure into molds, and fused into a homogeneous, tough, elastic film or molding by heating at a temperature of 300 to 350 F.

A vinyl resin made by copolymerizing 85 parts vinyl chloride, 15 parts vinyl acetate, and 1 part maleic acid was found to give coatings which adhere well to smooth surfaces after air-drying (18). The good adhesion is attributed to the presence of unreacted carboxyl groups contributed by the maleic acid.

Resorcinol-formaldehyde resins (19), which cure rapidly at temperatures from 60 to 150 F, under nearly neutral conditions, have been found to be especially advantageous for assembly-bonding of wood and other materials which are deteriorated by the strong acids used in cold-setting urea and phenolic glues. One resin of this type, called "Penacolite," has been used in the production of laminated white-oak timbers for shipbuilding, manufacture of plywood sheet and tubing, and bonding of plastics, rubbers, and metals. The potential fields of application for these resins in the postwar market include laminating, molding, casting, coatings, and grinding-wheel production, as well as bonding of parts for marine use, aircraft, furniture, and building construction.

Portents of things to come in furane resins (20–22) were described during 1944. The raw materials for these resins include furfural, furfuryl alcohol, and furoic acid. One hundred per cent furane resins which can be molded, laminated, cast, sprayed as air-drying coatings, and used as adhesives and impregnating agents have been developed experimentally.

Important advances were made in the fabrication and utilization of laminates. The unsaturated polyester resins, such as the Columbia resins (23), Laminac, Marco resins, Monsanto 38691, and Plaskon 900, were used to bond glass fibers into sheets which were tested for mechanical strength and other physical properties (24). The rear fuselage section, tail cone, and side panels of the BT-15 airplane were constructed by the Army Air Forces Aircraft Laboratory (25) of glass cloth bonded with Plaskon 900 and subjected to static tests. Detailed information (26–30) on other aspects of the preparation and properties of low-pressure glass laminates was published in conjunction with the announcement of the construction and flight tests on this first successful laminated-plastic aircraft primary structure. The influence of various factors on the mechanical properties of paper-base laminates (31, 32) and applications (33, 34) for this type of material were discussed by several authors.

The terms "sandwich materials" and "expanded (or foamed) plastics" have been frequently mentioned in the plastics literature of 1944 and are destined to become common parlance during the next few years. The advantages of sandwich construction involving stiff dense faces separated and stabilized by a thick light core have long been known. In the aircraft industry considerable interest has been stimulated in sandwich materials by the ever-increasing difficulty of maintaining rigid contours in high-speed aircraft. This type of construction was employed for the resin-glass fuselage built by the Army Air Forces. Excellent discussions of the principles and problems involved have been published recently (35, 36). Balsa wood has generally been employed on aircraft as the porous stabilizing medium, but research is in progress currently to develop more satisfactory low-density materials from plastics. Phenolic and urea resins, polystyrene, polyvinyl chloride, cellulose acetate, allyl resins, and natural and synthetic rubbers have been expanded into porous structures by various methods (35–38).

Significant reports were published concerning impact-resistant moldings made with pulp (39) and creped paper (40), use of resins in impregnating and bonding wood (41–46), and plastics made from lignin (47, 48) and wood (49). Agricultural products as sources of raw materials for the plastics industry were considered in papers dealing with plant residues (50), starch (51–53), and zein (54, 55). Other noteworthy papers dealt with the structure of phenolic resins (56), increasing the solvent resistance of cellulose-ester moldings (57), and polyvinyl alcohols (58).

MOLDING AND FABRICATING

The sweeping advances in the development of high-frequency preheating equipment, and the utilization of this technique in speeding production and solving heavy-section-molding problems make this process outstanding in the roster of 1944 accomplishments in the plastics industry. The record on industrial parts now being heatronic-molded (59–62) is one of amazing reductions in curing time with concomitant savings in manpower and machine hours. Curing time of a propeller block is reduced from 12 min to 2 min; telephone handset, 8 min to 3 min; airplane control pulley, 5 min to 1 min; ignition part, 6 min to 1 min. The process has also found further application in the fabrication of parts from plywood (63, 64) and laminates (65).

The principles involved in high-frequency heating were reviewed by several authors (61, 66, 67). The normal path of the electrons of nominally nonconducting molecules is disturbed by the rapidly alternating electric field, releasing energy in the form of heat. This dielectric hysteresis is comparable to the generation of heat due to mechanical hysteresis when a rubber band is stretched and released rapidly and repeatedly. It has been suggested that, aside from the temperature aspect, the molecular agitation caused by high-frequency heating also greatly accelerates the intermolecular change that takes place during polymerization.

The adaptation of the injection- and extrusion-molding processes to thermosetting plastic materials has been another high light of the year. This represents a potential shift of the favorable price factor for small molded parts, in which molding costs bulk high, back to the thermosetting materials which lost it 10 years ago to the injection-molded thermoplastics. One machine with motor-driven screw has proved in tests to be satisfactory for injection molding and continuous extrusion of thermosetting and thermoplastic materials and natural and synthetic rubbers (68). Experimental rocket-launching tubes have been made by the continuous-extrusion process with this apparatus. The injection-molding process has been used to make truck coil cases from a variety of thermosetting materials (69). Better strength properties, a 250 per cent saving in curing time, and reduction in the number of dies required are among the advantages attributed to this new molding technique. Other innovations in machines for injection (70–72) and extrusion (73) molding were described. Special problems relating to the extrusion of ethyl cellulose (74) and vinylidene chloride (75) were discussed.

Design of molds (76–78) and plastic parts (79–82) and the art of molding generally (83–85) were the subjects of many papers published during 1944. The long-standing problem of less costly molds was considered in reports on electrodeposition of molds (86) and the use of cast zinc alloys (87). Fabrication of thermoplastic sheets into aircraft parts and miscellaneous shapes was accomplished by free-blowing (88, 90) and die-forming (91). Further developments in metal-plating of plastics were reported (92–94). The opposite technique of plating plastics on other materials by an electrophoretic process was also described (95). Directions were given for depositing films of rubber, waxes, resins, cellulose, and bitumens.

New information on the spreading and curing of resinous glues in the manufacture of compreg (96) and plywood (97–99) was published. Further advances were made in the art of low-pressure molding and laminating (100–102). The postforming of thermosetting laminates, first described in 1943, became an important factor in the production of large parts for Army bombers, including fairings, ammunition boxes, ejection-chute

scoops, light brackets, and deflector rings (103). These postformed laminated parts require approximately one third the number of tools necessary for the forming of metal, cost about 50 per cent less than the corresponding metal parts, and are from 25 to 50 per cent lighter. The forming properties of vulcanized fiber were also described (104).

APPLICATIONS

The record of 1944, with respect to utilization of plastics in the war effort has also been primarily one of concentration on items tried and proved in the preceding 2 years. Bomb-burster tubes (105), M-52 fuses (106), rifle butts (107), resinous coatings for steel cartridge cases (108), medicine containers (109), medical equipment (110), mess trays (111), screening (112), and range-finding equipment (113), are among the long list of Army supplies employing plastics. In fact, the ordnance items mentioned here remind us that plastics, too, are ammunition and that the year-end emphasis on expanded production of bullets and shells means a further tightening of the supply situation. The lookout alidade (114), compasses (115), escape-hatch covers (116), and antifouling coatings (117) are among the Navy's requirements that continued to be met with plastics.

The outstanding new application of plastics for military purposes in 1944 was the rocket-launching tube (118). These tubes which are 10 ft long and have an inside diameter of $4^1/_2$ in. are mounted in clusters of three on the underside of fighter planes. They are made by rolling paper impregnated with phenolic resin onto mandrels and baking at 105 C for $6^1/_2$ hr. Among the advantages attributed to the plastic "flying bazooka," as compared to steel and magnesium tubes, are lighter weight, resistance to corrosion, and reduction of the hazards involved in the event of malfunctioning of the rocket equipment.

Another noteworthy development reported during the past year was the production and evaluation of the plastic housing for the 6 × 42 combat binocular (119). The rigorous requirements for dimensional stability in order to maintain alignment of the optical systems were met by the selection of a phenolic-asbestos composition and thorough stabilization of the housings by a baking treatment. The extreme resistance of the instrument to fungus growth, corrosion, and moisture penetration, and its superior behavior in maintaining optical collimation under impact conditions make the plastic binocular exceptionally well suited to amphibious and tropical operations.

The aircraft industry continued to be an important source of new activities in plastics. Several reviews of present practice and future possibilities in this field were published (120–122).

Applications described include glider control tabs (123), propeller parts (124, 125), turret units (126), oxygen equipment (127), portable hangars (128), navigational instruments (129), flooring (130, 131), and signaling lamps (132). Developments in transparent enclosures included a laminate made by bonding methacrylate plastic with an interlayer of polyvinyl butyral to produce for pressurized cabins a glazing capable of being penetrated by machine-gun and cannon fire without shattering (133). Aircraft safety glass (134) of an improved design, and streamlined eyes (135) for the B-29 are other 1944 newcomers in which transparent plastics are employed.

Kirksite dies were successfully employed for the molding of antenna-mast parts and inner-skin frames for aircraft doors (136). Detailed information was supplied regarding the use of plastics for drill and assembly jigs, machining fixtures, and mechanical press dies (137–139). Adhesives for bonding metal to metal or wood are of increasing interest to the aviation industry (140, 141). The development of a sprayed-on vinyl-resin film to protect aircraft during transoceanic shipment (142) took its place alongside the earlier practice of dipping metal parts in a molten ethyl-cellulose composition to protect them from corrosion and yet have them ready for immediate use by simply stripping off the plastic film (143).

The building industry continued to explore the possibilities of using plastics in prefabricated housing and other architectural outlets (144–147). Design, standardization, costs, and recommendations regarding research were considered in the report of a British committee on plastics for housing (148). The potentialities of the low-pressure glass-plastic moldings for prefabricated bathroom-kitchen units, refrigeration, furniture and household appliances are based on low tooling costs for large sections, light weight, and ease of assembly (149). Some thought has also been given to the place of plastics in fluorescent lighting fixtures for the home (150).

The textile and coated-fabrics industries are employing more and more resins, both in kind and volume, in supplying the demands of the Army and Navy. Comprehensive surveys of technological developments in synthetic fibers (151–154) included rayon, nylon, vinyl, vinylidene, casein, and glass types. Coated fabrics are employed in quartermaster equipment for raincoats, mountain tents, hospital sheeting, upholstery, bedding bags, and clothing interliners (155–157). Fiber treatments with resins to improve waterproofness, crease resistance, wearing qualities, dimensional stability, and handling properties are in a stage of active development (158).

Papers were published discussing the uses of plastics in the plating industry (159, 160), shoes (161), paper manufacture (162), protective coatings (163–165), transportation, (166–170), and physiotherapy (171–173). Developments in pattern plates (174), impregnation of castings (175), cable insulation (176), and brake linings (177) were described. Postwar applications of luminescent pigments (178) and of color in molded products (179, 180) were reviewed. A significant trend to informative labeling of plastic products was foretold, the background of this consumer-sponsored movement was outlined, and a plan for developing suitable labels for plastics was presented in an outstanding survey of this subject (181).

PROPERTIES, TESTING, SPECIFICATIONS

The year 1944 was marked by a further healthy growth of the technical literature on the properties and testing of plastics. The number of such references included herein is almost double that of the 1943 review.

Many valuable data were contained in the papers sponsored by the Rubber and Plastics Division of this Society. Three papers on plastics were presented at the Semi-Annual Meeting in Pittsburgh in June; these pertained to dimensional stability of laminates (182), strength properties of cellulose-acetate and cellulose-nitrate sheets (183), and postforming of laminates (184). Three further papers were given at the Annual Meeting in New York in November; these concerned creep properties of phenolic plastics at elevated temperatures (185), permanence properties of cellulose-acetate and cellulose-nitrate sheets (186), and properties of high-strength paper-base laminates (187). Other reports on plastics and related subjects published by the Society covered investigations of the resistance of phenolic and urea resinous adhesives in plywood to alternating stresses (188, 189), strength properties of glass (190) and wood (191, 192) laminates, and the fabrication and utilization of plywood (193–197).

The high light of the year technically was the symposium on plastics held under the auspices of the American Society for Testing Materials in Philadelphia in February (198). Included in this publication are papers on the heat resistance of laminates (199), effect of environmental conditions on the mechanical properties of plastics (200), diffusion of water through plastics (201), stiffness and brittleness of vinyl elastomers (202), behavior of plastics under repeated stress (203), testing of high-strength plastics (204), and creep characteristics of plastics (205). Five technical reports on plastics were presented at the annual meeting of that society in New York in June; these related to indentation hardness (206), impact testing (207), creep tests of paper-base laminates (208), flow properties of phenolic

laminates at elevated temperatures (209), and fatigue tests on compreg (210).

Important contributions were made to our knowledge of the creep (211, 213), shear (214, 215), impact (216), bearing (217), flow (218, 219), electrical (220), optical (221), and thermal-expansion (222, 223) properties of plastics. The water absorption and permeability to moisture of various materials were reported (224–228). Gas permeability of plastic films was studied by two authors (229, 230). Properties of plywood (231), compreg (232), phenolic laminates (233, 234), and methacrylate sheets (235) were described. Other topics discussed in the literature included the relation between test data obtained on standard specimens and the properties of molded-plastic parts (236, 237), solubility of plasticizers in liquid ammonia (238), and ion-exchange resins (239).

Three noteworthy contributions were made to the identification of plastic materials (240–242). A method for the determination of the plasticizer content of cellulose plastics was published (243). Tests for measuring impact strength (244), and scattering of light by plastics (245) were described.

Committee D-20 on Plastics of the American Society for Testing Materials completed action on five test methods, three recommended practices, and four new specifications for plastics (246). The testing procedures pertain to the measurement of flexural strength, indentation hardness, luminous reflectance and transmission characteristics and color, specific gravity, and stability of chlorine-containing plastics. The recommended practices are for determination of the permanent effect of heat, accelerated weathering of plastics using the S-1 bulb and fog chamber, and molding impact specimens of general-purpose phenolic materials. The four specifications covered cellulose-acetate sheets and ethyl-cellulose, methacrylate, and nylon molding compounds.

Standards for plastic fittings and tubing adopted by the National Aircraft Standards Committee were published (247). Tolerances for laminated plastics (248) were discussed, with emphasis on the specification of the maximum safe tolerance in order to expedite deliveries under wartime conditions.

The formation of A.S.T.M. Committee D-14 on Adhesives was announced during the year (249). Subcommittees on strength properties, analytical tests, permanence properties, working qualities, specifications, and nomenclature have been organized. The co-operative efforts of producers, users, and other interested parties in the activities of this committee should lead to uniform testing procedures and valuable data on the properties of all types of adhesives and promote the development of improved resinous bonding materials.

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A Cubic Inch of Wood

SOME astonishing facts about wood are given by Dr. Carl C. Forsaith of the New York State College of Forestry, Syracuse University. A cubic inch of white pine, weight for weight, is stronger than common steel. When it is air-dried it will support the weigt of nearly $2^1/_2$ tons lengthwise of the grain, although three quarters of its volume is air.

The block contains between four and five million cells of a certain type called "tracheids."

If placed end to end these cells would reach more than ten miles. White pine has three other kinds of cells. Organic matter constitutes approximately 99 per cent of the wood. Also there is to be found in it one third of all known elements. Less than one per cent is mineral matter and that is what is left in ash when the wood is burned. This comes from the soil.

Chemically it can be said that about one half of white pine is cellulose, from which photographic film, rayon, cellophane, smokeless powder, and other products are produced.

Dr. Forsaith also states that around one fourth of the block is lignin, which acts like a cement, uniting the wood cells. The chemical formula for lignin has not yet been determined.

Another quarter of white pine is made up of sugars, resin, wax, acetic acid, and pentosan (a kind of sugar which will not ferment).

Ethyl alcohol, which is exactly the same kind of alcohol that occurs in liquors and wines, can be made from wood.

ADVANCES *in* RUBBER *During* 1944

By JOHN W. LISKA

PHYSICS RESEARCH DIVISION, FIRESTONE TIRE AND RUBBER COMPANY, AKRON, OHIO

THE nature of the problems faced by the rubber industry in the year 1944 stands in sharp contrast to the major effort of the preceding year. Having solved the essential and primary problem of "rubber" supply in a commendable manner (1),[1] there remained logically the secondary, though really no less essential, problems of the production of "rubber" goods of all types, in large quantities, from the several important synthetic rubbers, particularly GR-S, the "tire" synthetic. Although many of the natural-rubber compounding practices employed by the rubber technologists were carried over, with considerable success, to the compounding of GR-S, it is also a fact that the highest quality GR-S products are not always produced by techniques or practices known to be successful with compounds having a natural-rubber base.

Since all of the available synthetics lack one or more of the desirable properties of natural rubber, it was necessary that the highest possible quality be attained in the synthetic products in order to minimize their known deficiencies. The same exhaustive tests, which had resulted, after years of experimentation, in the development of high-quality natural-rubber products, had to be repeated on the synthetics as quickly as possible. As in the preceding year, when considerable progress was made along this line, much of this work was again done by specially appointed industry-wide committees, and the results were made available to the entire industry without the formality of publication in the literature.

In the current year, however, the results of many such investigations were released for publication through the efficient censorship clearance of the Rubber Director's Office. Among the many comprehensive studies, which resulted in a rapid increase in the quality of synthetic-rubber products, are those on the effects of pigments (2, 3, 4, 5, 6, 7, 8, 9, 10, 11), processing (12, 13), softeners (14), blending of synthetics (15, 16, 17, 18, 19, 20, 21), the effects of milling (22), compounding practices (23, 24, 25, 26, 27, 28, 29, 30), vulcanization and molding of synthetic goods (31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41), the effects of sunlight, ozone, and aging (42, 43, 44, 45, 46, 47), and the development of new physical and chemical methods of testing and evaluation (48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65).

The armed services' greatly increasing requirements for compounds which retained their flexibility at low temperatures were met by the introduction of specially designed synthetics and additional, new, low-temperature plasticizers (66, 67). Improved methods of evaluating low-temperature flexibility have been developed and described (68, 69, 70, 71, 72, 73).

Additional data on cellular rubbers have been published (74), and new products made from this type of material, battery separators (75), and upholstery material (76), have been announced.

EXPANSION, THE KEYNOTE OF SYNTHETIC-RUBBER INDUSTRY

At the time of this writing the nontechnical phases of quantity production, adequate manpower and manufacturing capacity, have not been satisfactorily solved. Production in some lines, particularly large-size heavy-duty tires for the armed services is lagging behind schedule because of both of the factors mentioned (77, 78). Civilian tire production, which of course rates a considerably lower priority, is consequently still farther behind anticipated schedule. In view of this situation, the keynote of the entire industry during the current year has been expansion. In some instances, production of war materials was transferred to new locations, thus freeing existing production space and facilities and experienced labor for tire manufacture (79). In others, large new plants for the manufacture of tires and tubes were designed and built, or are being built, in regions of relatively high labor availability (80, 81, 82, 83, 84, 85). In spite of the tremendous increase in the amount of synthetics produced in the preceding year, further expansion, particularly in the line of specialty rubbers, was effected in the current year (86). The completion and achievement of full operation of the government's synthetic-rubber plants on the Pacific Coast were also announced during the year 1944 (87). Significant, too, was the report of the completion of two standard GR-S plants and one GR-I plant in Canada (88).

Allied industries kept pace during this expansion period with the development of new types of pigments, and building or planning of new plants for their production (89, 90, 91, 92) and the building of new plants for the production of high-tenacity (tire-cord) rayon (93).

A number of new "elasticators," plasticizers, and tackifiers were introduced (though not nearly in as large numbers as in the preceding year), (67, 94, 95, 96, 97, 98, 99, 100, 101), in further attempts to overcome some of the chief manufacturing difficulties involved in the substitution of synthetics for natural rubber.

New types of polysulphide rubbers, Thiokol type ST (102) and type LP-2 (103) were announced. The former is reported to have greatly improved resistance to cold flow while retaining the excellent solvent resistance of this class of material. Experiments on Guayule rubber have been continued (104, 105, 106), but the difficulties of quantity production and extraction continue to keep this natural rubber in a position of importance secondary to that of most of the synthetics.

IMPROVEMENTS IN TIRE SYNTHETICS STUDIED

It will be recalled that in the interests of vitally important speed, standardization, and full utilization of all available technological skill, the entire government-directed synthetic program was based on an original and fundamental decision to make but one "tire rubber," GR-S. Until full production was achieved, most of the experimentation was confined to attempts to improve the basic GR-S polymer, rather than along the line of modification of the basic polymer or the development of a completely new tire rubber. The obvious success of the synthetic-rubber program to date is sufficient proof that this decision was a wise one for that critical period. However, as soon as an adequate supply of synthetic rubber was assured, the investigations of new and improved tire rubbers and new manufacturing methods were gradually expanded.

The design of all the standard GR-S plants was based on a batch polymerization process, which was carried over from laboratory investigations. Generally speaking, the production rate of an intermittent process is not as high as that of a continuous process employing equipment of approximately the same size. Consequently, the announcement of a new, continuous polymerization process (107) is of some interest and importance. Because of the increased production rate possible

[1] Number in parentheses refer to the Bibliography at the end of the paper.

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by this method, it is reported that existing plants are capable of producing 40 per cent more synthetic rubber than present capacity figures indicate.

It is too early to state how much better than GR-S the new synthetics are, since many details have not yet been made available nor have the results of extensive tests been made public as yet. Copolymers of dichlorostyrene and butadiene are reported (108, 109) to have excellent tensile, stretch, low-temperature properties, milling characteristics, tear resistance, and low-heat generation and gas permeability. Better oil resistance than GR-S (though not as good as neoprene or Thiokol) is claimed.

Complete information on another new synthetic will not be released until after the war (110). A reduction in tread cracking, increased abrasion resistance, and greater tackiness are reported for this synthetic. A further feature of this material is revealed in the claim that no major capital expenditures or changes in existing government GR-S plants are required.

High resistance to high-octane gasoline, high tear resistance, and excellent aging properties are said to feature "Uskol," (111) another new synthetic which, according to claims, can be produced with present equipment, handles easily during manufacture, and which blends with other synthetics.

A fourth new synthetic, introduced in the current year, is reported to be a copolymer of butadiene and an as yet unnamed chemical (112). It is claimed to have low heat build-up and crack growth, but is more expensive than GR-S at present. Virtually no details have been made public regarding a fifth synthetic announced (113), though the process has already been made available to the entire industry. This development is said to embrace a technique by which a modified rubber, having special advantages, is produced.

As important as are the foregoing announcements, their real significance lies in the possibilities still in the future. There now appears to be a good chance that one or more of the synthetic tire rubbers will be able to compete favorably with natural rubber on a quality basis even after the end of the war when natural rubber again becomes available in quantity.

A number of fundamental studies of the polymerization process (114, 115, 116) and of the molecular structure of synthetics (117, 118, 119, 120) have been published during the current year. These, together with the large amount of unpublished committee work along these lines, are responsible, to a considerable degree, for the rapid development of the new and improved copolymers mentioned. That further advances can be expected is detailed in a timely report on polymerization and the future, by a man who has been for many years recognized as one of the foremost scientists in the field of the chemistry of natural rubber, (121).

Widely heralded as one of the most significant advances of the year is the successful incorporation of carbon black into GR-S latex on a factory-production scale (122). The method, not yet adopted to any considerable extent, is claimed to yield vulcanizates having better physical properties, in some respects, than those produced in the usual manner, i.e., by milling or incorporating the carbon black in a Banbury mixer. Some milling is required even when the carbon black is introduced into the latex, but a large saving in power consumed and in milling time is claimed. This development had its origin, like many another new production method, in extensive laboratory studies, some of which had been previously described in the literature (123, 124). With production facilities limited and production schedules seriously lagging, any process by which milling time can be reduced, thus making increased production rates a possibility, should be a valuable "assist" to the rubber industry and is one which will doubtless be put to further tests in the coming year.

Reports on the compounding of neoprene latex (125) the use of synthetic latices for wire insulation (126) and for fabric coating (127) have also been released, indicating a strong trend toward exploitation of this manufacturing technique. The first successful tires made with latex body stocks were built and described in the current year (128).

ARMY RELEASES SERVICE DATA ON TIRES

A gradual lessening of war censorship has resulted in the release of information on many of the ways in which rubber, both natural and synthetic, is helping to win the war. The U. S. Army Ordnance Department has released an extensive report on GR-S tires designed for military use (129, 130). Though admitting that GR-S tires do not stand severe overloading nor sustained high speeds, the Army has expressed its complete confidence in synthetic-rubber tires. Further tests on synthetic tires and tubes are given in a report on the operation of the government test fleet at San Antonio, Texas (131).

One of the most vigorously debated questions was apparently settled during the year 1944. The War Department is quoted as believing that rayon is superior to cotton in most tires, for heavy service, such as the Army car and truck (132). Civilian tests (on bus company fleets) also indicate a definite superiority of rayon over cotton. The claim is made (133) that in sizes 7.50/20 and up, 25 to 30 per cent more tires would have been required, over a given time period, if it had not been for the use of rayon.

INNOVATIONS IN AIRPLANE TIRES

Several innovations in airplane tires and landing gear have been described. A new airplane ice tire, with removable lugs, is claimed (134) to make landings on icy runways considerably safer. A self-starting airplane tire, in which prerotation is achieved by means of vanes or fins in the sidewalls of the tire (135), is reported to increase the number of landings a tire can make before failure. An ingenious "flying runway," is also described (136). This device is reported to make landings and take-offs possible on swampy or soggy soils, where even super-balloon tires bog down or cause the plane to nose over.

A new airplane-tire testing machine has been built at Wright Field (137). Each newly designed synthetic tire is tested here under the same tremendous stresses to which it is subjected in actual service. Investigations of this kind are enabling tire designers to minimize some of the shortcomings of the synthetic rubbers and to utilize their better features to a fuller extent.

Rubber airplane propeller cuffs which step up plane speed and increase engine-cooling efficiency are reported (138). Lifesaving balloons made of rubber, each having a lifting power of 6000 lb, are being used to salvage Navy planes shot down over water (139). Heating pads, made of electrically conducting rubber, are being used to maintain gun breeches at the required temperatures for instantaneous firing at high altitudes, to prevent jamming of the guns at low temperatures (172). A new anti-icing boot is also being made of conducting rubber (112, 140). Additional data on this unusual application of rubber have been published in the past year (141).

WIDE RANGE OF WAR USES FOR SYNTHETIC-RUBBER PRODUCTS

Some of the war uses of Multipore have been released for publication (142). This porous rubber is being used in the preparation and filtering of blood plasma, in the silver-plating of bearings for airplane engines, in the filtering of fruit juices, etc. Many other industrial peacetime uses are predicted for this material.

Lifesaving suits and waterproof instrument bags, made of synthetic rubber, are being made for the Navy and Coast Guard Services. An ingenious combination of materials, asbestos and synthetic rubber, is being used in the manufacture of a collapsible container to be used for cooking and sterilizing (143, 144).

Destructive electrolytic action has been responsible for many expensive maintenance delays and replacements on the Navy's subchasers. This problem has been neatly solved by "flame-

spraying" Thiokol onto the steel propeller shafts (145). It is reported that the new process has been extremely successful in reducing replacements and maintenance to a minimum.

A newly patented gas mask which keeps fresh air circulating has been announced (146). Inflatable invasion boats made of synthetic rubber are reported, together with collapsible aircraft cargo containers, which are particularly good for shipping extremely corrosive materials, such as hydrofluoric acid (147). A rubber lifeboat large enough to hold 25 men and supplies has been described (148). A synthetic-rubber tape is being used to seal the fuselages, gun turrets, gas tanks, and Plexiglas enclosures of our warplanes against leaks caused by strains of battle maneuvers (149). Latex-dipped insulated wire is being used by the Army in large quantities (150). A new type lifeboat, especially designed to prevent the capsizing of inflatable craft of this type, has been announced (151). An extremely mobile, rubber-track vehicle, named the "Weasel" has been described (152). Another ingenious combination of materials, Thiokol and ground cork, is being employed as a substitute for rubber matting. This new, lightweight walkway coating is reported to adhere well to metal, plywood, and painted surfaces and is claimed to be resistant to fire, gasoline, salt water, oil, and hydraulic fluid, is easily applied; and dries quickly (153). The development of a tire-vulcanizing device employing electronic principles was discussed (154). This device, designed to replace Army tire-repair equipment weighing tons and taking hours to operate, is reported to be mobile, and through "internal" heating is said to make better sectional and spot cures within minutes.

COLLAPSIBLE CONTOUR MAPS AID IN INVASIONS

Important aids to our Armed Forces in the invasion of Northern France were collapsible rubber contour maps (155). These maps, made by spraying natural rubber latex on prepared forms, could be rolled up, after being thoroughly dried, into a small parcel for shipment in landing barges. After landing and expanding into strange territory our infantry and tanks were able, in many cases, to obtain much valuable information regarding the terrain simply by unrolling and studying these contour maps.

The electron microscope has been employed extensively in the comparison of natural- and synthetic-rubber fibers and in the study of the nature of carbon-black reinforcement (156, 157). There is much evidence to indicate that this physical research tool will be widely used in future years, as more and more laboratories announce purchase and installation of these extremely high-power microscopes.

At the symposium on the physics of rubber and other high polymers, held late in 1943, a number of important papers were presented by both academic and industrial physicists. Many of these papers have since been published. Included among these works are studies on the theory of elasticity of rubber (158), stress relaxation (159, 160), plasticity (161, 162, 163), X-ray diffraction and light scattering (164, 165, 166), hysteresis and elasticity (167, 168), second-order transition effects (169) and infrared analysis (170, 171).

DATA ON THEORETICAL AND PHYSICAL ASPECTS OF SYNTHETICS

The culmination of the activities of this group, begun at the physics symposium, was the organization of a new Division of High Polymer Physics, within the framework of the American Physical Society, in June of the year 1944 (173). Papers, soon to be published in the *Journal of Applied Physics*, were presented on such topics as the theory of elasticity, reinforcement of rubber, electrostatic properties of rubber and GR-S, speed of retraction of rubber, stress-strain-temperature relations, physical properties of natural and synthetic rubbers at low temperatures, molecular weights, and brittle points of high polymers. If the uniformly high quality of the papers presented by this group in the current year and the individual's interest and enthusiasm are at all indicative, future significant contributions to the knowledge and science of rubber can be expected.

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Some Recent Developments in ENGINEERING MATERIALS[1]

3 *Synthetics, Fuels, and Lubricants*

By ARCHIBALD BLACK

MANAGER, MECHANICAL ENGINEERING DEPARTMENT, SIMMONDS AEROCESSORIES, INC., NEW YORK, N. Y. MEMBER A.S.M.E

SYNTHETICS

SYNTHETIC SUBSTITUTES FOR RUBBER

To be chemically exact, the various so-called "synthetic rubbers" have no claim to this title since they are not exact chemical replicas of natural rubber. Five distinct groups have become generally accepted as "synthetic rubber," as a result of their having some chemical resemblance to natural rubber or having certain of the mechanical characteristics peculiar to natural rubber. However, in addition to these five groups, there are innumerable other synthetics and even crossbreeds of various synthetics which possess some of the characteristics of rubber; these are covered elsewhere herein under their chemical groups. The five synthetics just mentioned and the dates of their commercial introduction, either here or elsewhere, are: Thiokol 1929-1930, Neoprene 1931-1932, Buna-S 1937, Buna-N 1937, Butyl 1940.

Table 9 serves to illustrate the relative position of each of these types as to current volume of production and also to show the tremendous growth that has taken place in the past 2 years.

TABLE 9 U. S. A. SYNTHETIC-RUBBER PRODUCTION

Type	First quarter, 1943 long tons	Fourth quarter, 1944 (est.) long tons
GR-S (Buna-S)	3102	225000
Neoprene	4372	13000
Butyl	35	12000
Buna-N	2977	6500
Totals	10486	256500

GR-S (Buna-S) is a co-polymer of butadiene and styrene and resembles natural rubber in processing and service characteristics. It can be vulcanized with sulphur and most rubber accelerators and can be cured to any degree from extreme elasticity to "hard rubber." Its resistance to deterioration with atmospheric exposure is less than that of natural rubber. This type has already been used extensively for tires and similar products and is the "keystone" of the synthetic-rubber program. Owing both to its characteristics and the fact that it is in such large production, it looms up highest as the tire rubber of the future.

Neoprene is a polymer of chloroprene and, although not the very first synthetic rubber, was the first to attain large commercial volume. This synthetic has good resistance to chemicals and oils and excellent resistance to heat, air, and light. Its resistance to deterioration by light exceeds that of natural rubber and also of most other synthetic rubbers. Its dielectric strength is somewhat less than that of natural rubber; on the other hand, when properly compounded, it is flame-resistant, whereas natural rubber is not. Neoprene processes much like natural rubber and can be plasticized by the use of chemical plasticizers. However, it is subject to premature vulcanization if temperature conditions are not carefully controlled in processing. It cannot be cured to "hard rubber." This type of synthetic has been extensively used during the war for products requiring better physical properties than can be obtained from most other synthetics. Its prewar use was largely confined to oil-resistant products.

Butyl synthetic is a co-polymer of isobutylene and isoprene or butadiene. This is a type that may have future possibilities although its production at present is less than that of the other groups. It has the great advantage of being capable of production in quantity at low cost, but it has not yet shown properties equal to those of the Buna-S. It can be processed much like natural rubber but cannot be cured to hard rubber. Physical properties are slightly lower than those of natural rubber but chemical resistance is exceptionally good. It is outstanding in its high resistance to permeability by gases.

Buna-N synthetics are co-polymers of butadiene and acrylonitrile. This type of synthetic can be vulcanized to "hard rubber" but differs from rubber in some other characteristics, and some operations are more difficult to handle. Oil resistance is good to excellent; light resistance, poor.

The Thiokols (exclusive of Thiokol RD which was a Buna-N and is no longer made) are derived from organic polysulphides and have no chemical relationship to natural rubber. They possess the general characteristics of rubber but they do not fully equal its physical properties. They can be vulcanized like natural rubber but differ from it in that their resistance to aromatic hydrocarbons, oils, and solvents greatly exceeds that of natural rubber and most of the other synthetic rubbers. Due to this, the Thiokols have been found especially useful where exposed to solvents. They also exceed natural rubber in resisting deterioration by light.

General. It may be said that synthetic substitutes for rubber are somewhat different from it in processing characteristics, sometimes more difficult to process, are usually a little inferior to natural rubber in physical properties, but very much superior to it in their resistance to light, heat, solvents, and other causes of deterioration. Due to the interruption of the natural-rubber supply, no direct cost comparison can be made, but there is every reason for believing that even the cheapest of the synthetics will cost more than natural rubber after normal conditions return. However, improved performance of the synthetics should discount the price difference for a large number of applications and an import tariff might well bring a complete balance.

A series of flexible synthetics of the polyvinyl-alcohol type was introduced a few years ago and is marketed under the general trade names of "Compar" and "Resistoflex." This material may be considered as another member of the "rubber-substitute" group but it is especially resistant to aromatic

[1] The first installment, "Ferrous Metals," appeared on page 101 of the February issue; the second installment, "Nonferrous Metals," on page 190 of the March issue of MECHANICAL ENGINEERING.

Section 3 which falls outside the field of the Metals Engineering Division was not presented with Sections 1 and 2.

hydrocarbons, such as used in aviation fuels. It is flexible, transparent, and is highly resistant to toluol, xylol, benzol, and most solvents in common use. Some varieties of this material are said to remain flexible at temperatures as low as —70 F, and yet withstand as high as 300 F without injury. They are available in many forms, ranging from air-drying liquids to flexible solids; the group is described by its manufacturers as "compounded modified polyvinyl-alcohol resins," the name "Compar" being taken from the first letters of the description. In the form of tubing, either solid or fabric-reinforced, this material has been used to convey aviation gasoline and many aromatic hydrocarbons; in the form of sheet it is used to form gloves and aprons for protection of workers; as an air-drying liquid, it is used for protective coating on metals, fabrics, leathers, etc. When dry it forms a resilient film unaffected by most oils and solvents.

PLASTICS

Advances in the field of plastics have been so great during the past 10 years that the author finds it impracticable to do more than list some of the recent additions to this field, append a few comments on their properties, and refer the reader to other sources for more detailed information. If we eliminate the nonsynthetics like shellac, asphalt, natural rubber, casein, etc. the list of plastics enjoying any wide use 10 years ago was virtually completed by cellulose acetate and nitrate, phenol and urea resins, polyvinyl acetate and chloride, and alkyd and methacrylate resin. To these there have since been added such new groups as cellulose-acetate butyrate, ethyl cellulose, nylon, vinylidine chloride, polyvinyl butyral, polystyrene, melamine-formaldehydes, rubber-type glycol-acid resins ("Paracon"), new high-temperature vinyl ("Polectron Polymer," polyvinyl carbazok), hydrocarbon resin (polyethylene), and the carbon-hydrogen-silicon compounds ("Silicones"), as well as the groups covered elsewhere herein under "Synthetic Substitutes for Rubber." The list of crossbreeds between the groups makes the present variety of synthetics almost innumerable.

Among the developments of the past decade, the following might warrant some comment: The methyl-methacrylate resins and polystyrenes are synthetics of exceptional transparency. Polyvinyl-butyral resins possess a unique characteristic in the fact that they can be cured somewhat like rubber. The material can thus be made more resistant to heat and more nearly insoluble and can be molded like rubber. This class of plastic is now in use as molding powder, tubes, and continuous sheeting for safety-glass interlayers. When mixed with phenolic resin, it is used for waterproofing cloth which can be heat-cured like rubber. The melamine-formaldehyde resins have the advantage of high surface hardness, chemical inertness, relatively high flame resistance, and in not supporting combustion. Mineral-filled melamine-formaldehyde resins have exceptional resistance to the effect of electric arcing. Some of the new members of the vinyl-resin group have shown exceptional dimensional stability and resistance to many solvents. In the "Silicone" series, a group of plastics has been developed capable of withstanding temperature up to 500 F. An entirely new field has been established with the creation of the ethylene polymers. Chemically, this group is entirely different from any other group and consists only of hydrogen and carbon.

The newer alkyd resins are distinguished by their tough "rubbery" characteristics and can be vulcanized to form products with high resilience and flexibility combined with oil resistance, and also flexibility at very low temperatures. Some other synthetics, capable of processing to show rubberlike characteristics, have been covered elsewhere herein under the head of "Synthetic Substitutes for Rubber." Some applications of plastics are covered under "Glass-Reinforced Plastics," which follows. The economic importance of the recent developments in plastics may be judged from the figures on resins production, given in Table 10 (quoted from *Modern Plastics*).

TABLE 10 SYNTHETIC-RESIN PRODUCTION IN THE UNITED STATES

Pounds
1940—276,814,363
1941—437,799,687
1942—426,731,106
1943—651,511,000

GLASS-REINFORCED PLASTICS

This is an entirely novel development that has been undergoing investigation during the last few years. Basically, it is the application of glass-fiber threads to the reinforcement of plastics in much the same manner as steel bars are used to reinforce concrete. The results have been far-reaching. In experiments made by or under the direction of the Army Air Forces, an army basic-trainer airplane was constructed with a glass-fiber-reinforced plastic fuselage, and some other portions. The fuselage was assembled as a sandwich with a balsa-wood core surfaced on each side with a skin of plastic which was reinforced with glass-fiber cloth. Destruction tests were made of three fuselages which were similar except for their materials of construction; (*a*) glass-reinforced plastic, (*b*) metal, and (*c*) plywood. On a strength-weight basis, the glass-reinforced plastic showed up 50 per cent stronger than the metal and 80 per cent better than the plywood. The glass used was Fiberglas cloth (which had been heat-treated to volatilize off the lubricants used in weaving) and the short fine glass fibers marketed as "Fiberglas Flock." The plastics included various makes of co-polymer resins of a type that polymerize without elimination of by-products when setting, thus eliminating need of high pressure to prevent blisters and similar defects.

The experiments covered a number of glass-plastic combinations and were inspired by a desire to utilize the very high tensile strength and high elasticity of glass fiber to increase the strength of plastics. The glass fibers individually range around 300,000 psi in the sizes used, and as much as 1,000,000 psi has been attained in special cases. The modulus of elasticity of the fiber is between 8,000,000 and 9,000,000 psi. Tensile strength of the laminates was found to be roughly proportional to the amount of glass used, ranging from 43,360 psi to 54,720 psi; strength in flexure ranged from 45,350 to 84,600 psi. Modulus of elasticity in flexure was 2,200,000 psi, and specific gravity averaged about 1.75. All of these figures are for cross-laminated glass cloth. Strength values are about twice as high for parallel-laminated glass cloth stressed in the direction parallel to the fibers.

The finished lamination, despite its glass reinforcement, is still capable of being worked with a variety of tools although some special technique has to be used because of the hardness of the material. Tools should be of the cemented-carbide-tipped type, although it is possible to drill the sheets with high-speed-steel twist drills if care is taken to prevent burning the drill edge. Use of lubricants or coolants other than an air blast is not recommended, due to the risk of damaging the sheet. Dust from the cutting should be collected by a suction collector.

Although this is a very recent development and one that was conducted in secrecy until 1944, designers of various types of products are already giving it consideration for postwar use. Traveling bags, canoes, small boats, refrigerators, radio cabinets, and kitchen and bathroom units are among the applications that have been proposed.

WOVEN-PLASTIC FABRICS

Within the last few years there has been developed by the Firestone Industrial Products Company a new type of fabric for engineering applications. This is marketed as "Velon" and consists of drawn fibers of a synthetic of the vinylidene-chloride type. These are available in a range of gages, present fabrics being usually 0.011 in., and they are woven into colorful pat-

terns. The fabrics are not yet available for commercial use, their introduction having been delayed by military requirements, but the manufacturers expect the first applications to be for upholstering of automobiles, buses, railroad cars, etc. These fabrics appear to be exceptionally well suited to this application. They are very colorful, quite tough, exceptionally wear-resistant, cool to the touch, noninflammable, can be cleaned instantly by the application of a wet cloth, and are immune to all of the usual causes of damage to ordinary cloth, fabrics. The fibers show tensile strength of up to 40,000 psi. The same type of synthetic fiber is also to be marketed in a variety of colors in the form of screening for insect protection and similar purposes. In this case it has the advantages over metallic screening of being noncorrosive, nontarnishable, flexible but tough, and unaffected by exposure. In addition to the wholly synthetic fabrics, the makers also produce combination materials consisting of the same fibers interwoven with cotton, wool, rayon, or silk where some special appearance is desired. The makers expect to apply their fabric also to women's apparel, raincoats, house curtains, and similar articles of nonengineering nature.

MODERN FINISHING MATERIALS

General. The extensive development of the so-called "plastics" has made available for use as surface finishes an extended list of radically different and entirely new types of materials, since almost every member of the plastic group is capable of application to this use. Some of the plastics, particularly the cellulose group, have been used in finishing lacquers for years. More recent applications are such as the phenolic resins, alkyds, polystyrenes, urea-formaldehydes, acrylics, melamines, and vinyls, which are now being used in finishes. In a résumé of the entire field of synthetic coatings, published in 1942, O. P. Clipper of the Plaskon Company of Toledo, presented a comprehensive tabulation of 21 modern groups of finishes, showing their method of application, chief characteristics, and commercial uses.

In addition to their distinctly better physical characteristics, most of the modern finishes differ from the earlier ones in their method of drying. Early finishing materials dried either mainly or entirely by oxidation of a gum or oil. Since this oxidation did not stop at any given point, the finishing coat usually passed through a cycle of change from a liquid to a moderately soft and flexible film, then slowly increased in hardness, and finally became brittle and easily cracked as it aged. Recent types depend more upon polymerization or condensation and tend to reach a condition of stability after which relatively little change takes place with age. These modern finishes can be selected to meet any desired condition whether it be high resistance to extreme heat, extreme cold, high flexibility, extreme hardness, high dielectric strength, extreme water and solvent resistance, or freedom from loss of properties with aging. The characteristics of these finishes have made it possible to drastically reduce drying time by suitable technique. Within the past several years it has become common practice in production work to dry these finishes by the use of infrared rays. This method has been found to be more effective than the earlier method of using hot air as it reduces the tendency to "caseharden" the surface, which arises with some finishes. The infrared drying method is especially successful in connection with the finishes that dry by polymerization and condensation.

Alkyd-Group Finishes. Glyceryl-phthalate resin was the first of the alkyd group of synthetics to be applied as a finish, and it is now in general use for the compounding of water- and weather-resistant and heat-resistant varnishes and enamels. For maximum resistance to moisture, glyceryl phthalate is reacted in the kettle with tung, linseed, and similar oils to which solvents and driers are added. A film may be produced that, after air-drying for 48 hr, will withstand boiling in water for 10 min without damage and will also withstand all normal extremes of atmospheric heat and cold. It is highly resistant to gasoline and other solvents, in consequence of which it is in common use in aircraft. Another type of enamel, designed for high heat resistance, is compounded with glyceryl phthalate and carbon black for finishing the heads of aviation-engine cylinders, coil windings, and other parts that are exposed to high temperatures. This enamel withstands the boiling test and gasoline-resistance test as noted; also, it may be heated to 260 F for 24 hr without damage. While these represent only two of the alkyd-group finishes, they may be considered as fairly representative of the characteristics of the group.

Phenol-Resin-Base Finishes. The phenol-aldehyde resins, and various other combinations of these groups are in common use as finishes where exceptional resistance to weather, solvents, and some chemicals is required. One type of "spar" varnish that is in use today is compounded of phenyl-phenol-formaldehyde resin, dehydrated castor oil, tung oil, linseed oil, solvents, and driers. This is a clear varnish that is capable of withstanding extremes of moisture, heat, cold, and solvents such as gasoline. After air-drying for 24 hr, it is capable of withstanding boiling water for 7 hr, and immersion in ordinary (lead-free) gasoline for 4 hr, all without damage. Weather resistance over the normal range of outdoor temperatures is excellent. Other varnishes of this type show similar characteristics.

Urea-, Melamine-, and Vinyl-Resin Finishes. These represent some of the later additions to the modern finishes. Some utilize urea and melamine resins as their base and dry mainly by condensation instead of partly by oxidation as with most of the other finishes. Because of this, some of these finishes can be dried in a surprisingly short time; in certain cases it has been found practicable to complete an infrared curing cycle in as little as 2 min. Despite this drying speed, the physical characteristics of these finishes are exceptionally good; indeed, they are claimed to produce a film that is tougher and more abrasion-resistant than any other finishing material that can be applied by painting on the surface. Another new series of finishes is based upon the utilization of the vinyl resins. Some of these finishes are characterized by extremely high chemical inertness, being little affected by most alkalies, oxidizing agents, water, and most solvents. Being of the thermoplastic type, vinyl resins do not have the high heat resistance of some other finishes. They also show some tendency to yellow under exposure to ultraviolet rays.

The few examples of modern finishes, which have been cited, must not be taken as a complete description. Modern finishes now constitute such an extensive list that it would be impracticable to go further than mention these examples here.

IMPREGNATION MATERIALS FOR POROUS CASTINGS

The time-honored practice of treating porous castings with sodium silicate or applying a surface coating of a conventional type paint has now given way to the process of impregnation, using organic synthetic compounds. These compounds are similar to the synthetic organic resins used in various finishing materials. The chief advantage of sealing microporosity by impregnation is that a casting treated in this manner will be more completely sealed, and therefore resistant to high pressures of either liquids or gases. Castings are impregnated by vacuum and pressure or by placing the castings in a fixture so that the liquid can be forced into the walls of the casting. Sodium silicate has also been used with this vacuum-pressure process of impregnation but has the disadvantage of being an alkaline inorganic compound and thus reactive with certain metals such as aluminum and magnesium. It is also somewhat abrasive in nature and therefore a hazard to cutting tools and bearing surfaces. In addition, it is a water solution usually containing more water than silica, so that the efficiency or the degree to which it can seal is impaired; castings impregnated with sodium silicate have to be protected from water.

The newer synthetic materials, such as glyceryl phthalate,

phenol and vinyl resins are relatively heat-resistant, as well as resistant to various chemical agents. Glyceryl phthalate was first used for this purpose in the 1930's. Phenols and vinyls were used in 1940 and were followed later by the urea- and melamine-type resins which dry by polymerization rather than wholly or partly by oxidation. These resins are used in an organic-solvent solution that is similar to the sodium-silicate-water solution, and this solvent is drawn off or driven out of the casting by heating. A more recent improvement in 1943 was the use of a synthetic resin designed to co-polymerize with monomeric styrene, the styrene acting as a solvent for the resin and the two co-polymerizing, forming a complete 100 per cent solids-impregnating resin. This differs from the former resin solutions in that the monomeric styrene acts as the solvent, so that everything impregnated into the casting remains as a sealing agent. The degree of sealing efficiency thus attained offers considerable improvement over former methods and the styrene synthetic-resin co-polymers are also very resistant to heat and solvents.

STRIPPING LACQUERS

Whereas paints and lacquers are invariably developed to obtain the maximum amount of adhesion to the surface covered, the stripping lacquers are the reverse. These coatings were introduced about 1942 and are designed to provide the minimum of adherence to the coated surface so that they can be readily removed when desired. A number of firms are now producing stripping lacquers for coating metals, plastics, and other materials. These are cellulose lacquers and are applied either by spraying or hot-dipping according to the type of lacquer. They air-harden quickly (in about 5 to 10 min) to a thin pliable film that covers the surface completely but has only slight adherence to it. Thus when it becomes necessary to remove the protective lacquer film, it can be stripped off by hand. Normally these stripping lacquers are used clear; sometimes they are tinted. Normal application requires a film about 0.001 in. thick for sprayed, or $^1/_{16}$ in. to $^1/_8$ in. for dipped coatings. This method is now being used for a variety of purposes such as the protection of metal parts, camshafts, gears, etc., for factory handling or shipment, and the protection of transparent plastic window material against injury during assembly.

RESINS IN HIGHWAY CONSTRUCTION

What has been described as a "revolutionary approach" to the problem of soil stabilization in highway construction is taking place in the application of pine-resin derivatives to the waterproofing of soil. After a test of soil samples to determine the requisite amount, the resin is applied by distribution in powder form over the soil which is to be treated, this soil being relatively dry in the meantime. The spread area is thus thoroughly mixed to insure even distribution of the powder, after which the water in the soil is adjusted to the quantity most suitable for compaction, and the treated soil is compacted by rolling. The net result is to leave a soil from which moisture vapor can escape, but the penetration of additional water will be greatly retarded. The method is proving effective for stabilizing soil which contains appreciable quantities of clay. The construction must be done when the soil is not excessively wet.

SYNTHETIC SAPPHIRES

For many years the exact chemical composition of the so-called "precious stones" has been well known and carried in most handbooks on chemistry. Some such stones have been made synthetically for years. Synthetic rubies and sapphires have been produced in Europe for about 40 years but only in recent years, and as a result of interruption of foreign supplies, has the United States engaged in the production of synthetic sapphires and rubies. Both stones are a form of corundum; chemically the ruby is chiefly aluminum oxide and chromic oxide and is red in color; the sapphire is aluminum oxide, titanic oxide, and some other compounds, the color ranging from blue to yellow, depending upon the exact composition. Natural rubies and sapphires have been used for many years as pivots for fine instruments, watches, etc. The two stones are approximately equal in hardness, or about 9 in the Mohs scale, and thus particularly well suited to use for bearings.

Basically, the manufacture is by fusing aluminum oxide in an oxyhydrogen flame and building up the fused material to form a "boule." This emerges as a single crystal which can be produced clear or in a variety of colors. The crystal develops internal stresses as it grows and is split longitudinally to relieve these before cutting up for bearings. The average boule is 200 carats but boules have been formed in sizes up to 300 or 400 carats, or about $^3/_4$ in. diam and about 2 in. long. The water-clear type formed by pure alumina is used for most instrument bearings but the ruby type is preferred by watchmakers; undoubtedly a carry-over from the original practice of using natural rubies for watch jewels.

Development of synthetic sapphires in the United States has brought some new departures, one being the manufacture of this material in rod form, a type which Europeans had not succeeded in producing despite their long experience in this field.

SYNTHETIC SPINEL

Still another development is the creation of a synthetic spinel. This is magnesium-aluminum oxide and can be produced clear or in colors. It is not as hard as the sapphire but is distinctly harder than steel and glass, and therefore may be expected to find its own special field. The present application is as a gem stone for which purpose it is produced in birthstone colors. Spinel has a high index of refraction and low chromatic dispersion and thus offers promise in optical applications. Production methods are much the same as those used in making sapphires. Physical constants of these products are given in Table 11.

TABLE 11 PHYSICAL CONSTANTS OF SAPPHIRE AND SPINEL

	Sapphire	Spinel
Composition	Al_2O_3	$Al_2O_3.MgO$
Melting point, deg C	2050	2135
Chromatic dispersion (N_F-N_C)	....	0.012
Index of refraction	1.760–1.768	1.72
Specific gravity	4.0	3.6
Hardness Moh's (diamond = 10)	9	8 to 8.5
Chemical resistance	Excellent	Excellent
Water absorption	0	0
Coefficient of thermal expansion per deg C	Parallel to C axis, 0.0000062 Perpendicular to C axis, 0.0000054	0.0000059

BORON CARBIDE

Extensive research on the part of the Norton Company resulted in the production, in 1933, of pure boron carbide (B_4C), which is the hardest material synthetically produced on a commercial basis. If we eliminate the tiny and crude diamonds that are claimed to have been made synthetically at great cost as a laboratory experiment, boron carbide is the hardest material ever made by man under any condition. Prior to its synthetic production, the pure form had not been found anywhere in nature, and forms available contained such impurities that they were of little value where extreme hardness was required. The synthetic boron carbide, marketed as "Norbide," is made by fusing together, in an electric furnace, completely dehydrated commercial boric acid and high-purity coke. The temperature required to produce the reaction is about 4470 to 4650 F. The carbide thus produced is about 99 per cent pure. The compressive strength is about 300,000 psi, or less than that of cemented tungsten carbide, but the hardness is distinctly greater than that of either the cemented tungsten carbide or

silicon carbide; indeed it is exceeded only by the diamond. Despite this great hardness, the carbide is light, its specific gravity being only 2.52 which may be compared with 2.70 for aluminum.

Its coefficient of thermal expansion is 0.0000045 per deg C, (25 C to 800 C), or about one third that of steel. The melting point is in the neighborhood of 4440 F. By use of the Knoop indenter, used for measuring very hard materials, boron carbide and other materials are graded as listed in Table 12. The Knoop number is approximately comparable with the Brinell number of a material over at least the lower end of the Knoop scale.

TABLE 12 COMPARISON OF HARD MATERIALS

Material	Knoop No.
Topaz	1250
Carboloys	1050 to 1500
Sapphires	1500 to 2000
Alundums	1620 to 1680
Silicon carbides	2050 to 2150
Boron carbides	2250 to 2260
Diamonds	6200 to 6500

After leaving the electric furnace, the raw carbide is in lumps which have to be crushed, screened, and graded as to size before being suitable for use as abrasive material. Molded shapes are made by sintering the graded particles under high pressure and high temperature until they fuse together into a homogeneous mass without the use of any cementing medium.

Boron carbide is now being used as an abrasive for lapping cemented-tungsten-carbide tools and other very hard materials. It is also used for sandblast nozzles and many other applications for which extreme hardness or wear resistance are desirable. Boron carbide is also used in metallurgy as a convenient means of introducing boron in melts of steel and some nonferrous metals.

SILICONES

The Dow-Corning Corporation of Midland, Mich., has developed a new series of synthetic compounds which might be considered as a crossbreed between the plastic and the glass groups. This group is a series of organo-silicon-oxide polymers, now being marketed under the general name of "Silicones," and the compositions range from liquid and pastes to solids. Information on the chemical composition has not yet been released but the group is derived mainly from silicon, brine derivatives, and coal or oil derivatives. They have already been applied to such purposes as lubricants for high- and low-temperature use, and varnishes and greases for insulation. The group is characterized by most unusual resistance to change in viscosity under exposure to high and low temperatures, the operating range of some of the lubricants being given as from —70 F to 500 F. In the form of a resin, one of this group is used as a high-temperature-resisting varnish for insulating armatures and such purposes. By use of glass-fiber braiding, impregnated with this "silicone," insulated wire is being made which is capable of withstanding indefinitely a temperature of 175 to 250 F. Some of the "silicones" in paste form are used for insulating purposes in magneto connections and such.

MICA CERAMIC

A composite insulating material marketed under the trade name of "Mykroy" is substantially powdered mica cemented together with glass. It is made by powdering mica, mixing this with boric acid and lead oxide, and subjecting the mixture to very high pressure and high temperature until it fuses solidly together. The finished material possesses all of the general characteristics of mica plus some of those of glass and has the advantage of being very adaptable to molding. It is produced in rods and sheets, or is molded to almost any desired form. This material possesses exceptional insulating properties, especially for the high frequencies used in radio and electronics. It is very highly heat-resistant and will withstand continued exposure to temperatures as high as 1000 F, without deterioration, and possesses the moisture-resistant and nonporous characteristics of glass. It is very hard but can be machined, tapped, ground, and polished; carbide-tipped tools are desirable but not essential. Mykroy is now being used for such applications as insulators, mounting strips, and many parts of electronic apparatus.

FOAMED SPONGE RUBBERS

A new type of cushion rubber was being widely promoted shortly before Pearl Harbor and is likely to come into general use in the postwar period. This general type of material is now marketed by several firms under various trade names. It consists of rubber or synthetic rubber which is beaten up into a foam while it is still in the liquid stage, as distinguished from the original type of sponge rubber which is made by a different process. When solidified it forms an exceptionally resilient material ideally suited for use as cushions for seats or other applications. It can be formed to any shape, or may be cut as desired and, where additional resiliency is required, it is perforated. It has already been used for seats in buses, rail cars, and automobiles, and for upholstering of chairs as well as many shock-absorbing purposes.

FLAME-SPRAYED RUBBER

A technique for flame-spraying of some of the rubberlike synthetics was developed by Schori Process Corporation, of Long Island City, N. Y., and put into practical operation in 1941. A number of the so-called "plastics" has been experimented with and satisfactory results have been attained with powdered "Thiokol," "Cardolac," polyvinyl butyral, and polyethylene. In general, the process is similar to the metal-spraying process but requires the special equipment developed by this company for spraying powders. The powder is aspirated into the gun and is blown through an oxypropane flame at high velocity. The gun is held about 8 in. away from the surface to be coated. The molten material solidifies on the surface and coatings are normally built up to about $^1/_{32}$ in. This process has been used with "Thiokol" for protection of marine propeller shafts, condenser plates, chemical tanks, and similar applications; good adhesion is claimed.

FUELS AND LUBRICANTS

HIGH-OCTANE AVIATION FUELS

Up to 1924, the best gasoline in use had an octane rating of about 70. By 1930, the development of tetraethyl lead made possible the increase to an octane rating of around 87, the maximum figure attainable with the distillation processes then available being just over that or about 90 to 91. Development of the "cold-acid-polymerization" process made possible the delivery (by Shell Oil Company) of the first experimental 1000 gal of 100-octane fuel in 1934. In 1936, the "hot-acid-polymerization" process was introduced and by 1939 several firms were going into production with the "sulphuric-acid-alkylation" process. In the alkylation process, two or more gaseous hydrocarbon molecules are combined (by catalytic action of an acid) to form a larger molecule having an antiknock quality, after the addition of tetraethyl lead, considerably better than 100 octane number.

The next important development was the introduction of catalytic cracking. In this type of processing, the petroleum fractions are treated under pressure and at high temperature, and in the presence of a catalyst, to yield a product containing substantial percentages of isoparaffinic and aromatic hydrocarbons, both desirable constituents of aviation gasoline. There are now in operation several processes operating on this

principle; the main ones are (*a*) Houdry, (*b*) fluid catalyst, and (*c*) "thermofor" catalytic cracking.

In making finished aviation gasoline, the catalytic-base stocks are blended with alkylate blending agents and tetraethyl lead to produce a fuel having an antiknock value greater than that of 100 octane number. Frequently, the antiknock value is so high that straight-run gasoline can be blended into the fuel without falling below 100-octane rating. It has been estimated that the increase from 91 to 100-octane-number fuel has made possible an increase of about 25 per cent in engine output by permitting higher supercharging.

Still further improvement in aviation fuels is technically possible, but at a serious sacrifice in quantity. To allow an increase in power without knocking and with the present fuels, some engine installations provide for injection of water into the fuel-and-air mixture. This has the effect of reducing detonation with high compression yet further.

LOW-TEMPERATURE GREASES

Increase in the operating ceiling of airplanes brought them into zones of extremely low temperature, with resulting troubles from "frozen" controls, as the bearing greases became exceedingly stiff. This forced the development of a series of low-temperature greases of which there are several of different types now on the market. Without exception, however, all of these greases have a base consisting of one or other of the metallic compounds. At first "aluminum-soap" greases were used. These consist of aluminum-stearate soap, compounded with selected mineral oils, and are satisfactory for use within the temperature range of —40 F to 150 F. As performance of airplanes was further increased, the temperature range became too great for these aluminum-soap greases to meet and the Army called for operating range of —70 F to about 175 F. To meet this wide range, lithium-soap-base grease was developed which consists mainly of lithium-stearate soap, compounded with special mineral oil. This grease was found capable of satisfactory operation over an exceptionally wide range and is recommended for —70 F to as high as 250 F. However, some producers of these greases recommend the use of lower maximum temperatures where exposure to this condition is to be an extended one. It is marketed in two types, a low-pressure and a high-pressure.

LEADED GREASES

For some purposes it has been found that the lubricating value of a grease subjected to extremely high pressure can be increased by loading the grease with lead powder. This method has been applied to the lubricating of hemp-center steel-wire ropes, in which case the regular lubricant was used with the addition of 15 per cent by weight of lead. A few years of service showed that wire strands wore less in the cases where lead had been added.

WATER-SOLUBLE OILS

Although water-soluble oils are not new, they have recently undergone improvement and have received greatly increased acceptance. In 1942, water-soluble oils with high "wetting" characteristics were introduced. These oils were intended mainly for machine-tool cutting operations but have also been found suitable for deep-drawing of aluminum and some other metals. These are petroleum-base high-viscosity oils, compounded with sulphonates, and have all of the characteristics of a mineral oil until water is added, whereupon they emulsify with the water and become water-soluble. This water solubility may be used to dilute the oil as well as to facilitate its removal when the metal is being cleaned after the operations have been completed. If allowed to remain on the surface, these oils also afford protection against corrosion.

(*To be continued*)

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GEARED NONCONDENSING STEAM TURBINE LOCOMOTIVE, DEVELOPED BY THE PENNSYLVANIA RAILROAD, THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, AND THE BALDWIN LOCOMOTIVE WORKS

(Designed for fast, long-haul, passenger and freight service, the locomotive can operate at speeds up to 100 mph. Two turbines—one for forward motion and one for reverse—are connected through double helical reduction gears to the middle two of the four driving wheels. The forward unit, which is composed of six stages, is always engaged with the main gear pinion; the reversing unit, a single-stage Curtiss type, is connected only when the controls are in reverse. Steam pressure at boiler outlet is 310 psi gage and the temperature is 750 F. It is stoker-fired.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Gas Turbines and Jet Propulsion for Aircraft

Gas Turbines and Jet Propulsion for Aircraft. By G. Geoffrey Smith. Published in England by Flight Publishing Co., Ltd.; in the U. S. A. by Aerosphere, Inc., New York, N. Y., 1944, third edition. Cloth, $5^1/_2 \times 8^1/_2$ in., 122 pp., 76 figs., $3.

Reviewed by C. Richard Soderberg[1]

THE author of this compact treatise on "Gas Turbines and Jet Propulsion" is managing editor of the British publication *Flight*, and his series of articles in this magazine on the same subject, which started in 1941, represented the first fairly complete public announcement of an engineering development which has deeply stirred the public, technical and nontechnical alike. The first two British editions of this book apparently preceded the present third edition by only a relatively short time. In the earlier editions references to British developments were severely restricted for security reasons. This has been corrected in the third, American edition, and the notable work started by Group Captain Whittle takes its rightful place in the history of gas turbines and jet propulsion.

The book is thoroughly descriptive in character, and by means of a review of the patent literature, the author succeeds in giving a fairly complete perspective of the various developments which in recent years have culminated in the jet-propulsion plane. It is through no fault of the author that in the majority of the schemes described, no conclusion can be drawn as to their practicality and ultimate form. Even in the case of the British developments, none of the essential details of design have been disclosed. While the reader is left to form his own conclusions as to what is likely to remain visionary and what will emerge as practical reality, the scope of the descriptive material is very wide, extending into such topics as the Heppner contrarotating compressor-turbine plant, the water vapor and other cycles for planes, and boundary-layer control through judicious disposition of air intakes and jet discharge. The last two chapters are devoted to personal notes on the men associated with the British development and a summary of the author's talks on the broadcasting programs for the BBC, when the jet-propelled aircraft was first described to the public. An introduction by T. P. Wright, and a foreword by Sir Geoffrey de Haviland, give some very pertinent remarks on the significance of this new phase of aircraft propulsion.

The jet propulsion of planes probably will have a profound influence on the future development of aircraft, particularly in respect to the factors which determine economical speeds and altitudes. It is well to bear in mind, however, that what is really taking place is the emergence of a new prime mover, the gas turbine. The inventors of a century ago saw the potentialities of this type of heat cycle but could not sense that a century of intensive engineering developments would be required for the realization of these potentialities. The steam engine, the internal-combustion engine, the steam turbine, and the aeroplane itself apparently were all necessary experiences before the engineer was ready to tackle successfully, in the form of the gas turbine, the original caloric-engine cycle. Propulsion by jet followed as a more or less natural sequel for the airplane, because for the first time the circumstances were right for the application of this simple idea. Even if jet propulsion should remain limited to military purposes, however, the gas turbine and propeller drive are certain to play an important role in aircraft developments of the future. This book is eloquent testimony of the many curious by-paths which the minds of the inventors have followed in the evolution of this idea. It can be recommended to anyone interested in gaining perspective of this fascinating field.

[1] Professor, Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. Mem. A.S.M.E.

The Modern Gas Turbine

The Modern Gas Turbine. By R. Tom Sawyer. Prentice-Hall, Inc., New York, N. Y., 1945. Cloth, 6×9 in., 216 pp., 129 figs., $4.

Reviewed by C. Richard Soderberg[1]

THE recent literature on gas turbines and allied subjects is scattered through periodicals and transactions of engineering societies, and much of it is of a highly specialized technical nature. As the interest in this most recent of our prime movers is becoming more widespread, there is undoubtedly a considerable demand for less technical and more entertaining summaries of the progress made so far. Mr. Sawyer's book is a worth-while attempt to fill this need.

The first three chapters cover a brief introduction, a descriptive review of the fundamentals involved, and a historical review. The historical significance of the caloric engine is mentioned, but it would seem to justify further emphasis, because the present wave of interest in the gas turbine is in a sense a vindication of the appraisal made more than a century ago by the inventors of the hot-air engines. They laid the groundwork from the point of view of thermal cycles, even though their attainments fell short of even the steam cycle of their day, due to the inadequacy of the mechanical means at their disposal. The internal-combustion engine proved to be a better method of approach, as far as liquid and gaseous fuels were concerned. The steam cycle survived because of its ability to make use of coal, and the potentialities inherent in the turbine as against reciprocating machinery. The gas turbine required for its success the accumulated experience of these three major developments; when and if it can also make use of coal as a primary fuel, it may well become a serious competitor to the steam power plant as well as to the internal-combustion engine.

The gas turbine as an adjunct to the Diesel engine is made the subject of chapter 4. The Götaverken scheme, the Sulzer high supercharger development, and the free piston power gas generator are properly emphasized as important methods of approach, even though the available data are very scant.

A review of the main characteristics of the constant-pressure cycles is given in chapter 5, prepared by Ronald B. Smith as a summary of a paper presented in 1943 before the Society of Naval Architects and Marine Engineers.

Chapters 6, 7, and 8 are devoted to gas-turbine applications to industry, marine service, and locomotives. The data are from recent technical literature. An interesting method for reversing gas turbines is given on page 118 without revealing its source.

The last two chapters, 9 and 10, are devoted to aircraft applications. The former gives a review of the exhaust turbine supercharger and some of its problems of control. The latter, which is partly based on a recent book by G. Geoffrey Smith, gives a rather complete discussion of the airplane-propulsion problem. In this the author has departed from the descriptive method used in the earlier portions of the book and added a theoretical discussion. So little has been published on this point, and so many misconceptions exist, that this chapter will be welcomed by many readers. While the information presented seems essentially correct, it appears to the reviewer that some of the essentials of this problem could have been stated more explicitly. It would also have been desirable to have this information related in some fashion to the basic cycle characteristics given in chapter 5.

When mounted in a plane a gas-turbine plant takes a certain amount of air from the atmosphere, in which process the plane experiences a certain drag due to the momentum change. Roughly, half of the power absorbed by this drag is recovered as compressor work. This gas is now further compressed and eventually heated by the burning of fuel. The useful work is the available energy from expanding this gas to the atmospheric pressure, less that required for the compression beyond that done by the ram and for the various losses. This available energy may be expressed as a theoretical exit velocity (c) relative to the plane. In pure jet propulsion this velocity is used wholly for propulsion by momentum change; in the pure propeller drive it is converted into torque driving a propeller.

The choice of compression ratio is clearly very essential in this connection, since it influences not only the air rate but also the work ratio. The optimum pressure ratio is obviously somewhat lower for the jet-propulsion case than for the turbine drive. The choice of jet area is of course related to the choice of pressure ratio as far as the jet propulsion-case is concerned. For the turbine drive there is a theoretical optimum jet velocity, stated on page 189 to be such that "the exhaust velocity to flight speed ratio is approximately equal to the inverse product of turbine and propeller efficiency." To reach this optimum condition, however, usually requires turbine dimensions beyond the practical optimum, so that the optimum jet velocity in the practical case becomes related to the choice of turbine exhaust area.

The data presented in Figs. 11, 12, 13 correspond to pressure ratios which are in the region of optional values. The comparisons made are not unreasonable, although a somewhat better case could be made for the air-cooled aircraft engine.

The designer of gas turbines, struggling with a multitude of baffling problems, will not find all the answers in this book, but his perspective will certainly be broadened by its review of the historical development, and the recent ideas in the major fields of application. The book should be particularly useful as an introduction to the subject for nonspecialists.

Sampling Inspection Tables

SAMPLING INSPECTION TABLES. By Harold F. Dodge and Harry G. Romig. John Wiley & Sons, Inc., New York, N. Y., 1944. Cloth, $6^1/_4 \times 8^1/_2$ in., 106 pp., illus., \$1.50

REVIEWED BY EUGENE L. GRANT[2]

NOT until the war is over will it be possible to know the many contributions of the Bell Telephone Laboratories to the allied war effort. One outstanding contribution, however, is not secret; in fact, its usefulness is proportional to the number of people in responsible positions in manufacturing industries who know about it and understand it. This contribution which started in 1923 and 1924 is the development of the techniques which have come to be known as statistical quality control.

[2] Professor of Economics of Engineering, Stanford University, Stanford University, Calif.

The two most useful tools of statistical quality control are the Shewhart control chart and the various types of sampling inspection tables based on a statistical approach to acceptance procedures. Literature giving in simple language a concise description of the Shewhart control chart has been readily available to allied war industries.[3]

However, the sampling inspection tables themselves and the description of their derivation and use have been available only in papers published in the *Bell System Technical Journal* and in reprints of these papers published as Bell Telephone System Monographs. The volume under review fills a need for available literature on the subject by reproducing the three most important of these papers under a single cover. The authors are members of the quality assurance group of the Bell Laboratories.

[3] See American War Standard Z1.3, 1942, "Control Chart Method of Controlling Quality during Production," and the earlier Z1.1 and Z1.2, 1941, pamphlets, "Guide for Quality Control" and "Control Chart Method of Analyzing Data," all published by the American Standards Association. These were reprinted as British and Australian Standards, respectively, by the British Standards Institution and the Standards Association of Australia. See also British Standard 600 R:1942 "Quality Control Charts," by R. F. Dudding and W. J. Jennett.

A serious obstacle to the improvement of acceptance procedures in industry is the illusion that perfection (in the sense of 100 per cent conformity to specification) is possible as the result of *any* inspection plan. This illusion is often cherished both by those who reject all sampling plans in favor of 100 per cent inspection, and by those adept sampling plans which accept a lot if a sample is perfect and reject it if the sample contains one or more defectives. In the case of 100 per cent inspection, the possibility of perfection is limited by inspection fatigue. In the case of sampling inspection, the laws of chance make it inevitable that if the product submitted for inspection contains a moderate percentage of defective articles, there will be some defective articles in the accepted lots.

The statistical approach to acceptance procedures frankly faces the fact that some defective items may be passed by any sampling scheme. It attempts to evaluate the risk assumed with alternative sampling procedures, and to make an economic decision as to the degree of protection needed in any instance. It is then possible to choose a sampling acceptance scheme which gives a desired degree of protection with a minimum total amount of inspection. The Dodge-Romig sampling inspection tables have been developed on this basis.

The authors have prepared four sets of tables, namely:

- I Single Sampling Lot Tolerance Tables
- II Double Sampling Lot Tolerance Tables
- III Single Sampling AOQL Tables
- IV Double Sampling AOQL Tables

The first two tables are based on the concept of lot quality protection. For example, the table for "Lot Tolerance Per Cent Defective = 2 Per Cent" gives for any lot size from 1 to 100,000 the sample size and maximum number of allowable defects in a sample, to insure that if a 2 per cent defective lot were submitted it would have only one chance in ten of being accepted.

The AOQL tables are based on the concept of average quality protection, and call for 100 per cent inspection of any lots which are not passed on the basis of the sample. The AOQL is the "average outgoing quality limit." Regardless of the

quality level submitted for inspection, these AOQL sampling schemes promise that in the long run the average level of the accepted product cannot be worse than the AOQL; it may, however, be considerably better.

"Single sampling" calls for decision as to acceptance or rejection of each lot on the basis of one sample from that lot. "Double sampling" involves the possibility of putting off that decision until a second sample has been taken. A lot may be accepted at once if the first sample is good enough, or rejected at once if the first sample is bad enough; if the first sample is neither good enough nor bad enough, the decision is based on the evidence of the first and second samples combined. In general double sampling schemes will involve less total inspection than single sampling for any given quality assurance. They also have certain psychological advantages based on the idea of giving a "second chance" to doubtful lots.

In their introduction, the authors point out that "for process and final inspections in many manufacturing plants, the AOQL double-sampling tables have retained first place in general utility." They did not point out, although they might appropriately have done so, that the principles developed by the authors in connection with these tables have formed the basis for similar tables widely used for sampling acceptance by the Ordnance Department of the U. S. Army, and more recently by other branches of the Army Service Forces. The terms "double sampling" and "AOQL" have become familiar to ordnance contractors throughout the United States.

The text which accompanies these four tables gives an explanation of their theoretical basis and gives advice regarding their practical application. Chapter 3, which reproduces a recent article by D. B. Keeling and L. E. Cisne of Western Electric Company, gives specific directions for the setting up of a double sampling AOQL inspection plan. This chapter contains three forms, "Layout for Standard Sampling Inspection," "Lot by Lot Record of Statistical Sampling Inspection," and "Summary of Results of Inspection" which have been the patterns for many similar forms developed in war industries using these methods.

The relationship between the Shewhart control chart and sampling inspection tables is suggested by the following quotation from Messrs. Dodge and Romig: "Quality control is achieved most efficiently, of course, not by the inspection operation itself but by getting at causes. It may be expedited by . . . . preparing quality-control charts . . . . and making the findings available to those directly responsible for the manufacturing process." In other words, the best protection against the acceptance of defective product is having the product made right in the first place. The Shewhart control chart helps make this possible; the sampling acceptance procedures may be viewed as a second line of defense.

This book should be in the library of every inspection department and should be available to all who have responsibility for planning inspection programs.

The Valley and Its People

The Valley and Its People. By R. L. Duffus. Photographic illustrations by Charles Krutch. Alfred A. Knopf, New York, N. Y., 1944. Boards, $6^3/_4 \times 9^1/_2$ in., 167 pp., $2.75.

Reviewed by W. R. Woolrich[4]

Attempts have been made by various writers to describe the achievements and activities of the Tennessee Valley Authority. The enterprise, with its many facets, has repeatedly defied comprehensive description, due largely to the inability of any person to look in from the outside and evaluate the relative merits of the multitude of Authority projects in progress concurrently.

In "The Valley and Its People," R. L. Duffus and Charles Krutch and his associates have, in a well-ordered book of eight chapters, teamed up in a most effectual production. Mr. Krutch, with his peculiar gift for photographing people and places with trueness and attractiveness, was in a position to select, for the more than one hundred illustrations, pictures that would comprehensively show an authentic story of the achievements of the Authority and of their impact to date upon the life and landscape of the seven southeastern states. Mr. Duffus, with his power of word description, has given a fair and unbiased account of the Tennessee Valley area and has accomplished what many writers fail to do—he has given to the reading world an interesting report of technical matters in a graphic and entertaining style.

Appraisal of the work accomplished by the Authority since 1933 is left largely to the imagination of the reader. The record is given in pictures, word descriptions, and factual statements, and from these the reader is expected to form his own estimate. While such a procedure is subject to the criticism that from such interesting reports readers may be convinced that all of the problems of the Valley States are now on their way to a fortunate solution, any attempted appraisal by the authors would have been subject to the more serious criticism that they were posing as authorities on sociological, economic, and scientific problems.

For those who are intent upon securing a better understanding of the Authority's work and achievement, "The Valley and Its People" is well designed to be informative and interesting. While it does omit the recording of the many yet unsolved problems of the Valley area, any person who has traveled over the Tennessee Valley before 1933 and again in 1943 is impressed by the multitude of economic improvements that have been given birth under the inspiration of the Tennessee Valley Authority leadership. The work of Messrs. Duffus and Krutch brings this same realization to readers who are not able to make these comparisons by personal inspection. Those who know the history of the area described will be impressed by the authenticity of the entire book.

[4] Dean of Engineering, The University of Texas, Austin, Texas. Mem. A.S.M.E.

Books Received in Library

Aerodynamics. By L. R. Parkinson. Macmillan Co., New York, N. Y., 1944. Cloth, $5^1/_2 \times 8^1/_2$ in., 112 pp., illus., diagrams, charts, tables, $2.25. This introductory work presents briefly both elementary and advanced phases of the science of flight. Beginning with the theoretical consideration of atmospheric properties and air flow over surfaces, the author continues with practical discussion of lift and drag, stability, and airplane performance. The final chapter explains the construction and use of wind tunnels.

Alignment Charts, Construction and Use. By M. Kraitchik. D. Van Nostrand Co., New York, N. Y., 1944. Cloth, $6 \times 9^1/_4$ in., 94 pp., charts, tables, $2.50. The opening section of this book provides a review of the algebra, analytic geometry, and determinants necessary for an understanding of the methods of chart construction. The representation of various equations is then discussed and illustrated by means of exercises. Applications are made to the fields of chemistry, engineering, manufacturing, and investments. Some of the charts given are ready for use.

École Polytechnique Fédérale, Publications du Laboratoire de Photo-Élasticité, No. 1. Etude expérimentale et théorique de la répartition des tensions dans les poutres encastrées. By M. Robert. S. A. Leemann Frières & Cie., Stockerstrasse 64, Zurich, Switzerland, 1943. Paper, 6×9 in., 144 pp., illus., diagrams, charts, tables, 9 Sw. fr., 5.80 rm. The distribution of internal stresses in a fixed beam is described in detail as determined from three transparent models. The theoretical calculations are verified by experiment with photoelastic methods and cover a varying set of conditions. Numerous tables and plates and a bibliography are appended.

Economics as Applied to Production and Factory Organization. By A. H. Huckle. Mitre Press, Mitre St., London, England, E.C.3, 1944. Cloth, $5^1/_2 \times 8^3/_4$ in., 139 pp., charts, diagrams, tables, 15s. This book presents a general review of the method of achieving economic co-ordination of the departmental activities throughout a manufacturing organization. Planning procedures are

given for estimating machine and labor requirements, for establishing factory layouts and production routing, and for tool and gage control. Sales budgeting, purchasing, costing, and other financial problems are also considered.

ENGINEERING CONTRACTS AND SPECIFICATIONS. By R. W. Abbett. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Limited, London, England, 1945. Cloth, $5\frac{3}{4} \times 8\frac{3}{4}$ in. 188 pp., diagrams, tables, \$2.25. Upon the basis of experience both as a teacher and a contractor, the author has attempted to present in compact form some of the legal and business aspects of the engineering profession. The legal considerations in construction work are summarized, the types of contracts are described, and the essentials of each type discussed. Examples of each type are shown. Bidding procedure is described. A chapter is devoted to specification writing.

ENGINEERING MATHEMATICS. By H. Sohon. D. Van Nostrand Co., Inc., New York, N. Y., 1944. Cloth, $6 \times 9\frac{1}{4}$ in., 278 pp., diagrams, charts, tables, \$3.50. This book is intended for engineering students who have completed the study of the elementary calculus and for graduate engineers seeking to bolster their present knowledge of mathematics. Determinants and matrix theory, Fourier series, differential equations, vector algebra, and vector calculus are important subjects dealt with in the text. The theory and solution of algebraic equations in general are effectively covered.

HIGH-SPEED COMBUSTION ENGINES: Design, Production, Tests. By P. M. Heldt, (twelfth edition of The Gasoline Motor) published by the author, Nyack, N. Y., 1944. Cloth, $5\frac{1}{4} \times 8\frac{1}{2}$ in., 776 pp., illus., diagrams, charts, tables, \$7.50. This standard work, now in its twelfth edition, provides a comprehensive reference book for engineers as well as a textbook for students. The separate working parts of the high-speed combustion engine are covered in detail, including chapters on the carburetor and ignition equipment not previously included. Theory, design principles, production practice, and operation are all given consideration, and two chapters are devoted to engine tests and the thermodynamic laws.

INTERMEDIATE AERODYNAMICS. By R. W. Truitt. Pitman Publishing Corporation, New York, N. Y., and Chicago, Ill., 1944. Cloth, $6 \times 9\frac{1}{4}$ in., 227 pp., illus., diagrams, charts, tables, \$3.75. The important elements necessary for the accurate application of aerodynamics are presented with sufficient descriptive material to emphasize their practical use. Thorough mathematical explanations are given for problems relating to the airfoil, drag, stability, load factors, propellers, slots, and flaps. A glossary of aeronautical terms is appended.

MACRAE'S BLUE BOOK AND HENDRICK'S COMMERCIAL REGISTER, 52nd annual edition, 1944–1945. MacRae's Blue Book Co., Chicago, Ill., and New York, N. Y., 1945. Cloth, 8×11 in., 3736 pp., illus., \$15. The major part of this standard annual buyers' guide is a comprehensive alphabetical list of products, with the manufacturers arranged alphabetically under each product. In some of the larger classifications there is a geographical arrangement first, then alphabetical. Preceding this section is a complete alphabetical file of manufacturers giving full addresses, capital ratings, and local distributors. A three-hundred-page list of trade names is included at the back of the volume.

METALLOGRAPHY OF MAGNESIUM AND ITS ALLOYS, a translation from the German by the technical staffs of F. A. Hughes & Co., Ltd., and Magnesium Elektron Ltd., of "Metallographie des Magnesiums und seiner technischen Legierungen." By W. Bulian and E. Fahrenhorst. F. A. Hughes & Co., Ltd., London, N.W.1, England, 1944. Cloth, $6 \times 9\frac{1}{2}$ in., 117 pp., illus., tables, 15s. This, the first book devoted solely to the metallography of magnesium and its alloys, appeared in Germany in 1942. The translation is by the staffs of British producers of the metal. The book opens with a short description of polishing and etching technique, which is followed by a description of the alloy constituents and impurities that are discernible in micrographs. The remainder of the book discusses 225 micrographs that are presented and the information that they reveal as to the nature of the alloy, its pretreatment and its faults. To the references in the original edition, the translators have added a list of non-German references.

METALS AND ALLOYS DICTIONARY. By M. Merlub-Sobel. Chemical Publishing Co., Brooklyn, N. Y., 1944. Cloth, $5\frac{1}{2} \times 8\frac{3}{4}$ in., 238 pp., \$4.50. Over 10,000 useful metallurgical terms are contained in this reference volume: definitions of metallurgical terms; compositions, properties, and uses of all important commercial alloys; physical constants and properties of the chemical elements; brief descriptions of machinery and processes used in modern metallurgy, etc. Many trade names are included.

MILLING MACHINE OPERATIONS. By L. E. King. The Macmillan Co., New York, N. Y., 1944. Paper, $5\frac{1}{2} \times 8\frac{1}{2}$ in., 123 pp., illus., diagrams, tables, \$1.75. A guide for apprentices and students in shop courses, intended to teach the performance of various milling-machine operations.

PEACE, PLENTY, AND PETROLEUM. (Science for War and Peace Series.) By B. T. Brooks. Jacques Cattell Press, Lancaster, Penna., 1944. Cloth, $5\frac{1}{4} \times 7\frac{3}{4}$ in., 197 pp., maps, charts, tables, \$2.50. Following a brief historical survey of the American petroleum industry, the author devotes several chapters to the importance of petroleum in our industrial economy with particular reference to war needs. Petroleum substitutes are discussed and the geographical distribution and political implications of petroleum deposits are thoroughly covered. The author emphasizes the steady decrease in new producing areas in the United States and discusses the problems arising in connection with the increase in our need for foreign oil.

PRODIGAL GENIUS, THE LIFE OF NIKOLA TESLA. By J. J. O'Neill. Ives Washburn, New York, N. Y., 1944. Cloth, $5\frac{3}{4} \times 8\frac{3}{4}$ in., 326 pp., illus., tables, \$3.75. This book is chiefly concerned with Tesla's talent as an inventor. It describes not only his discoveries within the field of electricity, but his work in other fields as well. Giving full credit to his status as a brilliant engineer, it also portrays the eccentricities which almost equally set him apart from the normal run of human beings. As the book shows, both aspects were in evidence quite early in life.

READJUSTMENT OF MANPOWER IN INDUSTRY DURING THE TRANSITION FROM WAR TO PEACE. (Research Report Series No. 71.) By H. Baker. Princeton University, Industrial Relations Section, Princeton, N. J., 1944. Paper, $6 \times 9\frac{1}{4}$ in., 112 pp., tables, \$1.25. The material presented constitutes an analysis of the policies and programs presently under consideration by industry for absorbing the returning manpower after the war. The results of a large number of discussions with industrial, union, and government executives are grouped under three headings: organization and extent of company planning; transitional adjustments in the present labor force; employment and reemployment of veterans.

ROCKET RESEARCH, History and Handbook. By C. P. Lent. Pen-Ink Publishing Co., New York, N. Y., 1944. Stiff cardboard, $6 \times 9\frac{1}{4}$ in., 102 pp., illus., diagrams, charts, tables, \$5. The early history and present status of the development of rocket and jet propulsion are well presented in this small volume. The author covers both theory and practical application, including descriptive material on the various types of weapons brought out by the war. The text is illustrated by more than one hundred photographs and diagrams, and 150 American and British patents are listed.

SHEET METAL, Theory and Practice. By J. C. Butler, drawings by L. O. Genereux. John Wiley & Sons, Inc., New York, N. Y., Chapman & Hall, Ltd., London, England, 1944. Cloth, $8\frac{1}{4} \times 11\frac{1}{4}$ in., 173 pp., illus., diagrams, charts, tables, \$3. This concise, practical, self-instruction guide gives methods for handling successfully tools and machines, material allowances, blueprint reading, soldering, fluxes, welding and riveted assembly as used in sheet-metal shop practice. The material was originally prepared as a training program in marine sheet-metal work, and the emphasis is on marine applications.

SYMPOSIUM ON PLASTICS, Philadelphia District Meeting, American Society for Testing Materials, February 22-23, 1944. Published by American Society for Testing Materials, Philadelphia, Pa., 1944. Paper, 6×9 in., 200 pp., illus., diagrams, charts, tables, \$1.75; cloth, \$2. Of the sixteen papers by authorities in the field presented in this publication, the first eight deal with such topics as the heat resistance of laminated plastics, diffusion of water through plastics, and the behavior of plastics under certain conditions and test methods. The rest of the papers are grouped together as a summary of properties, uses, and salient features of the following families of plastics: phenolics, polystyrenes, urea and melamine, allyl, vinyl, cellulose, methacrylate, and nylon plastics.

THEORY AND PRACTICE OF JOB RATING. By M. F. Stigers and E. G. Reed. Second edition. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1944. Cloth, $5 \times 7\frac{1}{2}$ in., 168 pp., charts, tables, \$1.75. The first three chapters deal with the general theory of wages and wage calculation and with the basic principles of job rating. The succeeding six chapters describe the technique for the actual work of job rating and discuss the uses of the final result in comparing jobs. Emphasis is placed on methods of securing data that will substitute facts for opinions.

TREATISE ON THE MATHEMATICAL THEORY OF ELASTICITY. By A. E. H. Love. Fourth edition. Dover Publications, New York, N. Y., 1944. Cloth, $6 \times 9\frac{1}{2}$ in., 643 pp., diagrams, charts, tables, \$3.95. This standard widely known treatise has been out of print for some time, and this republication will be welcomed by many engineers and physicists. It is an American reproduction of the latest English edition, complete in every respect.

VIBRATION ANALYSIS. By N. O. Myklestad. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1944. Cloth, $5\frac{1}{4} \times 8\frac{1}{2}$ in., 303 pp., diagrams, charts, tables, \$3.50. The first five chapters are written from the textbook point of view to provide an understanding of the various phases of the phenomenon of vibration. Important topics covered are undamped and damped vibrations of systems of one degree of freedom and vibrations of systems with more than one degree of freedom. The last chapter deals with applications to important practical problems, chiefly in the aeronautical field.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

"Convention by Mail" Planned in O.D.T. Ban on National Meetings

Papers for Publication Urgently Requested

REPRESENTATIVES of the four A.S.M.E. committees most concerned with the development of papers for presentation at meetings and for publication met on March 2 to discuss ways and means for encouraging members to continue their contributions to mechanical-engineering literature during the war period.

Program-making agencies—the professional divisions and the technical committees—are urged to redouble their efforts to secure as many papers as normally would be solicited for presentation if national meetings were being held. In soliciting a paper, these agencies are requested to inform the author that, if recommended and approved, his paper will be published by the Society, and opportunity may be afforded him to present it at a local section meeting.

Members Urged to Offer Papers

Members who have suitable papers available or in process of preparation on subjects relating to the wide field of the activities of the Society are urged to write the Secretary offering such papers for publication. These papers will be referred to the professional divisions or committees of the Society into whose field they would actually fall, and, following the customary review and recommendation, they will be published in MECHANICAL ENGINEERING or Transactions.

Each paper published will carry a notice requesting discussion in writing and will bear the closing date for receipt of such discussion. Discussions and authors' closures will be published in later issues, as is now the practice in MECHANICAL ENGINEERING and the *Journal of Applied Mechanics*. Prompt publication of papers will be assured by this procedure.

Authors who are willing to present their papers before one or more of the local sections of the Society (presentation under such conditions is permitted under the rules covering the ban on national meetings) are asked to prepare a brief synopsis of fifty to one hundred words covering the salient features of the paper and indicate in what parts of the country they are willing to present their papers. This synopsis will be submitted to the local sections in the area of the country which the author indicates he is willing to visit. This practice is customary in England in The Institution of Mechanical Engineers. Presentation at local section meetings is strongly urged, but papers will be accepted for publication even if the authors cannot present them.

Abstracts Due by May 1

The seventy local sections of the Society will have representatives at eight regional conferences of section delegates in May and early June. It is hoped that many members will have available for these conferences the abstracts of the papers they propose to submit for publication and presentation at local section meetings. Titles of papers and abstracts should be sent to the Secretary's office not later than May 1. Most local sections plan their fall programs before the summer vacation season.

Program committees of the local sections should write to the Secretary if they wish more information on papers available for presentation than may be found in titles and abstracts. The Secretary will endeavor to supply press proofs of the papers, if they have been set in type. If the papers have been printed and orders are received in advance, reprints for distribution at local section meetings may be obtained.

Honors and Awards

THE Board of Honors and Awards of The American Society of Mechanical Engineers is developing information leading to the awarding of various honors and awards including Honorary Membership. It is pointed out specifically that a nomination for Honorary Membership may be made by twenty-five members of the Society who shall state in writing the grounds upon which the nomination is made.

Information regarding candidates for any of the medals of the Society or for Honorary Membership should be in the hands of the Committee not later than May 1. It should be addressed to the Board of Honors and Awards, care of the Secretary's Office, A.S.M.E., 29 West 39th Street, New York 18, N. Y.

Detailed information regarding honors and awards of the Society will be found in the Society Records—Part I of the Transactions of the A.S.M.E. for February, 1945, a copy of which may be obtained upon request.

Actions of A.S.M.E. Executive Committee

At a Meeting Held at Headquarters, Feb. 23, 1945

A MEETING of the Executive Committee of the Council of The American Society of Mechanical Engineers was held at the headquarters of the Society on Feb. 23, 1945. There were present: Alex D. Bailey, chairman, who presided, R. F. Gagg, vice-chairman, A. C. Chick, D. W. R. Morgan, and A. R. Stevenson, Jr., of the Committee; J. H. Sengstaken (Professional Divisions), A. R. Mumford (Local Sections), J. L. Kopf, assistant treasurer, R. M. Gates, junior past-president, W. H. Larkin, chairman, Nominating Committee; C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary.

The Committee met at luncheon with L. A. Appley, chairman, and J. M. Juran, past-chairman of the A.S.M.E. Management Division.

The following actions were of general interest.

Joint Committee on Forest-Fire Prevention

Approval was voted of a joint committee of the A.S.M.E. Wood Industries Division and the Society of American Foresters "to further the manufacture and use of improved forest-fire-prevention and fire-fighting equipment." Representatives and alternates of the A.S.M.E. on this committee were named as follows: Henry S. Jones, Lakeland, Fla., Henry F. Kurz, Rochester, N. Y., and Edwin H. Brown (C. E. Frudden, alternate), and Forrest Nagler (R. K. Prince, alternate), Milwaukee, Wis. [See MECHANICAL ENGINEERING, March, 1945, pp. 157–160, "Foresters Request Co-Operation in Protection of Woodlands," by Henry Clepper and David P. Godwin.—EDITOR.]

Standard for Turbine Generators

Approval was voted of the draft of the Joint A.I.E.E.-A.S.M.E. Standard for Condensing Steam-Turbine Generators as a standard practice of the Society.

Applied Mechanics Meeting Postponed

It was reported that the executive committee of the A.S.M.E. Applied Mechanics Division had decided to postpone its meeting scheduled for Buffalo, May 18–19, 1945.

Prime-Mover Speed Governing

Approval was voted of one year's trial use of the recommended specification for Speed Governing of Prime Movers Intended to Drive Electric Generators.

Committee on Organization

Appointment of a Special Committee on Organization, authorized at the meeting of Jan. 26, 1945, to function until the permanent committee is set up and in the meantime (1) present recommendations for establishment of a Board of Codes and Standards, (2) formulate plans for additional boards, and (3) prepare a statement of duties and responsibilities of the secretary, was voted as follows: H. V. Coes and R. M. Gates, past-presidents; D. W. R. Morgan, member of the Council; Alfred Iddles and G. L. Knight, members at large; and Wallace Clark and E. H. Schell, alternates.

Members Returning From Armed Services

A statement proposing a program for assisting A.S.M.E. members who return from service in the Armed Forces, prepared by Frank D. Carvin, who had been asked to study the subject, was read. The program outlined in the statement was approved, with expressions of appreciation to Dr. Carvin. The statement of policy was referred to the Committee on Local Sections with a request that it take steps to secure the appointment of advisory committees in each section. It was voted to inform other societies, through the Joint Conference Committee, and to urge joint community action. It was also voted to recommend to the Joint Conference Committee that it support a national educational program, outlined by Dr. Carvin.

Regional Conferences

Tentative dates and meeting places of the Regional Conferences, to be held this year in the spring rather than the fall, were reported as follows: Group I, Waterbury, Conn., May 10–11; Group II, New York, N. Y., May 17–18; Group III, Schenectady, N. Y., May 14–15; Group IV, Atlanta, Ga., May 21–22; Group V, Detroit, Mich., May 24–25; Group VI, Lafayette, Ind. (Purdue), June 1–2; Group VII, Salt Lake City, Utah, June 8–9; Group VIII, Tulsa, Okla., June 4–5.

Presidential Address

It was voted to distribute the 1944 presidential address, "Engineers of Tomorrow," by R. M. Gates (MECHANICAL ENGINEERING, January, 1945, pp. 5–8 and p. 69) to members of the Society in the Armed Forces.

Chinese Society of Engineers

The Executive Committee noted a communication from Paul B. Eaton, dated February 19, 1945, enclosing a letter from T. E. Mao, China's leading engineer (civil) advising that the Chinese Society of Engineers (formerly the Chinese Institute of Engineers) has designated its president, Tseng, Yang-fu, to make the return visit to the engineering societies in this country. The Secretary was asked to thank Mr. Eaton for this information and to take the necessary steps to provide a suitable reception for the representative from China.

S.P.E.E. Resolutions

On the endorsement of the Engineers' Council for Professional Development it was voted to support the following resolutions of the Society for the Promotion of Engineering Education:

(1) That the term "vocational-technical" as applied in Senate Bill 1946 to programs of education and training or to subjects of instruction or in other manner should be eliminated so that provisions of this bill will not apply to the education of technical-institute type.

(2) That Federal advisory services in relation to educational programs of technical-institute type should be administered by the Division of Higher Education of the United States Office of Education.

Veterans Bureau Hospitals

The Secretary reported that S. Logan Kerr, chairman of the Consulting Engineering Group, accompanied by M. X. Wilberding, attended a meeting on Feb. 20, 1945, called by General Hines of the Veterans Bureau. In addition to General Hines and his staff, the American Institute of Architects and the American Society of Civil Engineers were also represented in a discussion relating to the construction of hospitals to the value of about $500,000,000. It is hoped that in this program the Veterans Bureau will use private engineering and architectural firms. General Hines appointed an advisory committee representing the three designing professions, the A.S.M.E. representatives on which will be S. Logan Kerr and M. X. Wilberding.

William B. Gregory

The Secretary reported the death, on Jan. 29, 1945, of William B. Gregory, manager of the Society, 1916–1919, and vice-president, 1920–1921 and 1921–1933.

Appointments

Approval was voted of the following appointments:

Special Research Committee on Mechanical Springs, A. C. Keller.

Power Test Codes Committee No. 4 on Stationary Steam-Generating Units, Frank X. Gilg.

National Honors, G. Edward Pendray (to replace W. G. Marshall).

Washington Award Dinner, Feb. 21, 1945, Chicago, F. H. Lane.

Management Division

At the luncheon meeting with L. A. Appley and J. M. Juran, of the Management Division, subjects discussed included: (1) Means of making papers available in publications and by presentation at local section meetings for the duration of the ban on conventions; (2) the Society's membership-development program; and (3) education for management.

Elevator Safety Code Resolutions on David L. Lindquist

DAVID L. LINDQUIST, member A.S.M.E., who died on Nov. 11, 1944, was well known in scientific and technical fields as the chief engineer of the Otis Elevator Company. He was responsible for outstanding inventions and developments in the elevator industry for the last 35 years. For his achievements he was honored by the American Society of Swedish Engineers in 1940, with the award of the John Ericsson Medal, and in June of 1940 he was also honored by the King of Sweden, who constituted him a Knight of the Royal Order of Vasa.

A native of Stockholm, Sweden, Mr. Lindquist came to the United States in 1902, joining the Otis Elevator Company shortly after his arrival. In 1911 he became their chief engineer. Through his accomplishments in his chosen field he became the recognized authority on all types of vertical transportation. Among the developments attributed to him are the gearless traction elevators, the micro self-leveling elevator which, with the later development of signal control, permits the highest car speeds; also the collective control for automatic operation by the passengers as in apartment houses. He also supervised the latest type of escalator development which has made them so universally useful.

After his death, the following resolution was drawn up by the Executive Committee of the Sectional Committee for the Elevator Safety Code:

WHEREAS, The Sectional Committee for the Elevator Safety Code has lost, through the death of David L. Lindquist, one of its original members; and whereas, he gave unstintingly of his time and effort for a period of twenty-two years, on the Sectional Committee, its Executive Committee, and on various subcommittees on which he served; and whereas, his acute discernment of the basic problems involved in matters concerned with the safety of elevators, and his intimate knowledge of the principles necessary for their solutions, acquired not only academically but also in more than fifty years of practical application and through his own research, made him a person on whom the Committee leaned for counsel and guidance; and whereas, in his own organization, in the Sectional Committee, and in the elevator industry, he worked unceasingly for continual advance in the development of requirements for safe methods and devices and the elimination of unsafe practices and equipment; and, whereas, he was known and loved by all of us for his human approach in all discussions and ability to reconcile unimportant differences without prejudice to his uncompromising insistence on the attainment of an ultimate safety goal; and whereas, in his parting, we have suffered the loss of a true, sincere, and able friend and co-worker; now therefore be it

Resolved, That we, the members of the Sectional Committee for the Elevator Safety Code express to his wife our sincere sympathy and our regret at his passing and be it further resolved: that copies of this resolution be sent to the bereaved wife, the National Elevator Manufacturing Industry, Inc., which he represented, and that a copy be spread on the minutes of this Committee.

A.I.C.E. Elects Officers

OFFICERS of the American Institute of Consulting Engineers elected for the ensuing year have been announced as follows: E. Rowland Hill, member A.S.M.E., president; and George S. Armstrong, member A.S.M.E., vice-president. James Forgie and Philip W. Henry were re-elected treasurer and secretary, respectively.

The President's Page

Changes in the Constitution of the Society

DURING the month of April you will be asked to vote on changes in the Constitution of the Society. While two of these involve changes in language only, the others, covering membership requirements and the organization of the Council, are of major importance. All these changes are recommended by the Council, and with one exception, noted later, all of them received practically the unanimous vote of the business meeting.

The requirement that a member shall be thirty years of age is to be removed, and the required number of years of active practice is to be reduced from nine to eight; this is recognition of the greater responsibilities assumed today by young engineers.

A new grade of membership to be known as "Executive Member" is to be created to provide for executives in engineering industry who decide important engineering questions but may lack some of the qualifications required for the Member grade. This proposed change was opposed by members of the Sections; at the business meeting the motion to submit this change to the membership was carried by a very close vote.

The change in the organization of the Council provides for eight Regional Vice-Presidents to be elected for two-year terms, and eight Directors-at-Large to be elected for four-year terms. Each Vice-President will be the leader in his region and will be the representative of his region on the Council. He will be responsible for the successful functioning of the Sections and Branches in his area and for the administration of national programs that affect the regions. The Directors-at-Large will be chosen from among outstanding men in engineering, regardless of residence.

This ballot is an important one and it is hoped that the results of the voting will represent the wishes of a substantial percentage of the members.

(*Signed*) Alex D. Bailey, *President*, A.S.M.E.

Among the Local Sections

Postwar Air-Cargo Transportation Must Meet Challenge of Speed and Economy

Col. H. R. Harris of Air Transport Command Tells A.S.M.E. Metropolitan Section

THE postwar future of commercial air-cargo handling and transportation hinges on the ability of aircraft men to develop combinations which will deliver by air as economically and as quickly as competing forms of transportation, Col. Harold R. Harris, Chief of Staff, U. S. Army Air Transport Command, Washington, D. C., told the Metropolitan Section of The American Society of Mechanical Engineers, at its meeting on Monday evening, March 12.

"When and if this is done," he said, "and this is a very big 'if'—we may expect the airplane to become truly a commercial freighter of the skies."

Harry Pack, chief of functional engineering and air-cargo development, Pennsylvania Central Air Lines, Washington National Airport, was the other speaker. The subject of the meeting was "Air-Cargo Handling." Leslie E. Neville, aviation editor, presided.

Col. Harris Gives 1944 Figures

"I feel that under the leadership of Major General Harold L. George the Air Transport Command has stepped many years into the future of air transportation and taken on a job which may not develop in the field of postwar commercial air cargo for some years to come," Col. Harris said. "How soon, is a challenge for the aircraft designers, manufacturers, and operators."

Describing air-cargo transportation as "still in the development stage," Col. Harris said that new and difficult situations were always to be faced but that the system as developed by the Air Transport Command was working effectively, as indicated by figures for 1944.

"In that year 402,000 tons of cargo alone were loaded and transported . . . roughly the amount required to fill a freight train with its locomotive in Boston and its caboose well inside the city limits of Portland, Maine. During 1944 the airplanes of the Air Transport Command carried cargo, passengers, and mail, a total of 857,511,531 ton-miles.

"Over the roughest and most difficult air route in the world—the well-known Hump from India to China—we carried some 250,000 tons in 1944, or a little more than twice the capacity of the Burma Road. These figures, I think, will adequately support my statement that Air Transport Command's cargo-handling methods do work and work well."

Col. Harris gave in detail some of the practical results obtained by the Air Transport Command, as they will affect the future of commercial air cargo. He said:

"We know that within pay-load limitations, sooner or later, anything that can be physically loaded into or on an airplane will be carried somewhere for some purpose some time. We know how to build floors to take more concentrated loads than are likely to be found in most commercial operations. We know how to fasten all types of loads so they won't shift in flight and still be easily released for unloading. We have come a long way in repackaging for air transport. We have useful forms for markers, tags, stickers, waybills, and records. We have a start toward suitable loading and unloading equipment. And last, we know that no cargo airplane now in general use has the ready accessibility and ease required for rapid and economic loading and unloading."

Mr. Pack Outlines Needs

Describing air-cargo handling as "one of the most important problems to be solved in the air-line industry," Harry S. Pack discussed improvements already made and outlined problems that must be solved for the future of commercial cargo handling. Among them:

Time to load and unload through the door of present planes is excessive. Movement of air cargo long distances over the airport is necessary and time-consuming—planes are widely separated because of wing span and taxi clearances. Loading and unloading from carts is necessary for sorting in terminal excessive number of handlings. Unloading and loading is necessary for transfer at air-line junction points. The total investment, i.e., complete airplane and crew, is held on ground a long time for loading and unloading. Congestion caused by the number of planes on the ground at once—also an excessive number of loading positions required at peak hours because of long ground time. Cruising speeds must be higher to compensate for the longer time on the ground increasing cost of operation, time required to compute aircraft weight and load distribution. Although it has been suggested that the planes be loaded on balance scales in the apron the degree of error introduced by wind and air conditions would probably be too great to accept.

In conclusion, Mr. Pack said:

"The sales factor in air transportation is speed—we go to great effort and cost to gain it in the air—we cannot afford to lose it on the ground—the tempo of the two phases of the operation must be related.

"The problem of ground handling in air-line operation has been comparatively neglected in the past, but since the advent of the war it has become a most critical factor directly affecting the utilization of the fleet of air transports where every minute saved in ground and maintenance time has meant another minute more for flying time.

"Before the war, mail and express loads were relatively light, but air cargo has increased tremendously during the last few years so that the time for loading and unloading has assumed a major role in air-line operations. Little thought was given to cargo space and loading facilities in prewar transport airplanes. However, this picture is changing and consideration is now being given to the aircraft cargo arrangements, ground equipment, and procedures in order to insure faster, safer, and more economical loading operations.

"Like shipping companies and other forms of transport before us, we are realizing that a significant part of our operating cost is encountered in our operations on the apron."

Anthracite-Lehigh Valley Hears Talk on High-Alloy Steels

"The Manufacture of Steel" was the subject of a talk by T. G. Foulkes, Bethlehem Steel Company, at the Jan. 21 meeting at the Hotel Easton, Easton, Pa. Mr. Foulkes discussed high-alloy steels, their place in the war effort, and probable outlook for their future use in the postwar world. A film on the same subject followed the lecture. Forty-two members and guests were present.

Baltimore Section Hears Talk on Chinese Industries

At the Feb. 26 meeting at the Engineering Club, Baltimore, Md., the Section heard K. Y. Chen discuss Chinese industries before the war, and the material and service requirements in the development of postwar industries.

C. A. Ross, Buffalo Section, Shows How Rope Trick Speeds Up Shoveling

The idea that wear and tear is easier on a good rope than on a good right arm was developed by Carroll A. Ross, consulting engineer and chairman of the Buffalo Section. He says by using a rope you can shovel almost as fast as you can walk.

"The first thing to do is to tie a rope around the shovel handle so tightly that the rope can't slip," explains Mr. Ross. "Then run the rope up over your right shoulder, take it under your left arm, and tie it in front of you.

C. A. ROSS DEMONSTRATES HIS SNOW-SHOVELING TRICK

The loop should be big enough so you can take it off without untying it.

"Next, take hold of the shovel handle with your left hand, and grasp the middle of the handle with your right hand. Make the rope between the shovel and your shoulder short enough so there's no load on your right arm. When you stand erect, the shovel will be off the ground a foot or so. The shovel just swings back and forth on the rope guided by the hand. Incidentally, this idea works best with a long-handled shovel."

This snow-shoveling trick with the accompanying picture of Mr. Ross was published in the *Buffalo Evening News* for February 5, 1945, in time to help his fellow citizens with their winter-long problem. However, there will be other winters, and you may be glad to have this tip.

Central Illinois Section Hears Talk on Supersonic Reflectoscope

Prof. F. A. Firestone spoke on "The Supersonic Reflectoscope" at the Feb. 8 meeting of the Section at the Jefferson Hotel, Peoria, Ill. He explained that the reflectoscope may be used for discovering flaws, cracks, or holes; for measuring the wall thickness of hollow castings or propeller blades where the opposite face to which the measurement extends is inaccessible; for measuring the bond of plated, soldered, or welded joints; or for measuring the grain size or crystal alignment. Sixty members and guests heard the talk.

Chicago Section Members Attend Washington Award Dinner

A group of members from the Chicago Local Section attended the Washington Award Dinner held in the grand ballroom of the Stevens Hotel, Chicago, Ill., on Feb. 21, when Dr. Arthur Holly Compton, dean, division of physical sciences, and chairman, department of physics, University of Chicago, Ill., received the award "for his research and teaching in the physical sciences increasing man's knowledge of the action of X rays and cosmic rays." The Washington Award was founded in 1916 by John Watson Alvord and is administered by The Western Society of Engineers on recommendation of a commission representing five engineering societies, of which one is the A.S.M.E.

Dr. Compton addressed the audience of over three hundred, in a talk quite understandable to the layman. His main point was that to be powerful, a country must be unified to great strength by intense co-operation of all its groups—scientific, technological, and engineering.

Roy V. Wright Speaks at Cleveland Section

Roy V. Wright, honorary member A.S.M.E., was the speaker at the meeting of Feb. 8 held at the Cleveland Engineering Society, Cleveland, Ohio. In his talk entitled "The Engineer's Status in the Community," Mr. Wright made a plea for the members of the engineering profession to become interested in good government and to look upon politics as a career worth following. The attendance totaled 100.

Colorado Section Meets With S.A.E.

A joint meeting was held with the S.A.E. on Feb. 15 at the Albany Hotel, Denver, Colo., when Prof. K. D. Wood spoke on "Preliminary Design of Helicopters With 'Encore' on Jet Propulsion." Professor Wood told of the early history of the helicopter and illustrated the early models with slides. Model propellers were used to demonstrate the flight of the helicopter, and complications and problems of control discussed, also illustrated with slides. Operation of the Army models XR4, XR5, and XR6 were explained. Professor Wood stated that the subject of jet propulsion was oversold to the public as good for high-speed flying but not appropriate to supersede the conventional plane for normal traffic. One hundred-fourteen members and guests were present.

"Ohio's Water Situation" Subject at Columbus Section

David H. Harker, chief engineer, State Water Board of Ohio, discussed "Ohio's Water Situation" at the meeting on Feb. 21 at Battelle Memorial Institute, Columbus, Ohio, to an interested audience. The subject was first treated generally and then with particular emphasis on the water problems confronting Columbus. A lively discussion period followed. Mr. Harker is the author of several articles on the subject and is a member of the American Waterworks Association.

Detroit Section Hears Talk on "Precision Casting"

R. M. Kerr, Jr., Kerr Dental Manufacturing Company, discussed the process used in casting intricate industrial parts with extreme accuracy of form and size, at the Feb. 6 meeting held in the Engineering Society Building, Detroit, Mich. His talk was illustrated with slides and exhibits. One hundred-sixty-five members and guests were present.

Lester S. O'Bannon, Speaker at Louisville Section

Lester S. O'Bannon, member A.S.M.E., was the speaker at the Jan. 18 meeting of the Section at the Cortlandt Hotel Grill, Louisville, Ky. His subject was "A Synthesis of Business Cycle Theory." Mr. Bannon said that two dimensions, trade and price, explain the interrelation of employment, wages, production, price, quantity of money, and its velocity at exchange; and that innovations and inventions explain the change of these two dimensions with a third dimension, time, producing the cyclical nature of economic phenomenon.

Memphis Section Hears A. O. Fabrin

The Section met at the Hotel Peabody on Feb. 2 to hear A. O. Fabrin, chief engineer, Layne and Bowler, Inc., Memphis, Tenn., give an interesting illustrated talk entitled "A Brief History of Stuffing Boxes." Mr. Fabrin has done considerable research on this subject and his talk was most informative.

Metropolitan Junior Group Meets With Junior Chemicals

A joint meeting of the Metropolitan Section, A.S.M.E., and the Junior Chemical Engineers of New York, N. Y., was held on Feb. 22, at 109 West 42nd St., New York, N. Y. C. C. Furnas, member A.S.M.E., director of research, airplane division, Curtiss-Wright Corporation, Buffalo, N. Y., spoke on "The Next Twenty-Five Years in Aviation." The paper is to be published in an early issue of Mechanical Engineering.

Mid-Continent Section Hears T. C. Jones

The Feb. 8 meeting of the Section was held in the Mayo Hotel junior ballroom, Tulsa, Okla., when the speaker, T. C. Jones, president, Electro Chemical Engineering Company, gave an interesting lecture entitled "Treatment of Water for Boilers, Internal-Combustion Engines, and Other Industrial Units by Means of an Electro Neutralizer." One-hundred members and visitors took part in the lively discussion which followed. The Weiss Supply Company, Tulsa, Okla., which sponsored the local appearance of Mr. Jones, awarded attendance prizes and had charge of the buffet supper.

New Development of Old Art Explained at Milwaukee

"Precision Casting in Steel" was the subject of Fred Vodoz who spoke at the meeting on Feb. 14, at the City Club, Milwaukee, Wis. Mr. Vodoz described precision casting in steel as a new development of an old art. He said that the technique is similar to that used by the dentist, refined to a high degree. He explained the processes involved, the difficulties overcome, and the practical tolerances obtainable. The talk was illustrated with slides and actual sample pieces. One-hundred members and guests attended.

W. S. Mount, Research Engineer, Speaks at New Haven Section

"Modern Petroleum Base Fuels and Their Engine Characteristics" was the subject heard at the Feb. 14 meeting at Mason Laboratory, Yale University, New Haven, Conn. W. S. Mount, research engineer, Socony-Vacuum Oil Company, in his talk, outlined the requirements of fuels for Diesel aircraft and automobile engines and explained what happens to each when used properly and improperly. He also discussed the difficulties encountered in making the various grades.

North Texas Section Asked "What Do You Want?"

At a large meeting of the Section on Feb. 12, in Dallas, Texas, Alfred Iddles, fellow A.S.M.E., general engineering department, The

Babcock and Wilcox Company, asked "What Do You Want?" The question referred to design and construction of postwar boilers. Mr. Iddles is one of the country's outstanding experts on boiler design, and his audience learned a great deal, during his discourse, about what type of boiler construction they might expect both in large high-pressure high-temperature designs, and in boilers of more modest construction. In the discussion that followed his speech Mr. Iddles learned what Texas engineers want even if there is but slight hope of their getting all of their wishes. Much interest was displayed in forced-circulation design and its future possibilities in large units, and in special oil- and gas-burning equipment for more efficient use of these two native fuels of the Southwest.

Plainfield Section Hears C. A. Gladman

At the Elks' Club, Elizabeth, N. J., on Feb. 14, the Section heard C. A. Gladman, scientific officer, National Physical Laboratory, London, England, read his paper entitled "Drafting Room Practice in Relation to Interchangeable Components."

Symposium on Color at Providence Section

The Feb. 6 meeting at the Providence Engineering Society, Providence, R. I., featured a symposium on the use of color on machine tools and machinery in textile mills, as well as color on walls, floors, and ceilings in combination with more efficient arrangement of lighting to improve sight. The subject, "Color Conditioning—a Safety Color Code for Industry," was discussed by G. W. Badger of E. I. du Pont de Nemours and Company, H. A. Johnson of Federal Products, and W. Thompson of Thompson Engineering Company. Three films were shown to illustrate the talks, the first "Salvaging Waste Light for Victory," second, "Before and After," and third, "Seeing." Seventy-five members enjoyed the discussion.

Raleigh Section Hears Talk on Postwar Planning

At the meeting on Feb. 12, at the S&W Cafeteria, Raleigh, N. C., Felix Grisette spoke to 70 members and guests on "Postwar Planning for the State of North Carolina." He said that North Carolina has set up what is known as a planning board which helps coordinate various types of projects all over the state.

The board endeavors to evaluate the need of a public building or project, bring together the engineering or architectural profession with the representatives of the community, discuss the financial problem, and the problem of how to prepare for completion of the contract.

Schenectady Section Hears Talk on Shipbuilding

"Modern Methods in Shipbuilding" was the topic discussed by Harry W. Pierce of the New York Shipbuilding Company, at the Feb. 15 meeting in the Van Curler Hotel, Schenectady, N. Y. Mr. Pierce said that the title of his talk was somewhat of a misnomer as most of today's methods were originated years ago. He then described the basis of calculation of hull strength and methods of construction with particular reference to welding methods vs. riveting.

In conclusion, he described in detail a number of failures of welded and riveted ships. Mr. Pierce illustrated his discussion with lantern slides.

Southern California Section Visits Fontana Steel Mill

On Feb. 3 members of this Section were guests of the Kaiser Company's Iron and Steel Division at the Fontana Steel Mill. Luncheon was served in the mill cafeteria and the party was then conducted in two groups on a tour through the entire steel mill. On this field trip there were between 180 and 190 members and guests, presenting difficulties for the company to provide an adequate number of guides, but the tour was so well conducted that all agreed it had been well worth while.

The Section met again at the Hollywood Athletic Club, Los Angeles, Calif., on Feb. 13, to review the summer meeting of the Aviation Division in Los Angeles in 1944, in preparation for the summer Aviation Division meeting in June, 1945.

A. R. Stevenson, Jr., Speaks at Washington, D. C., Section

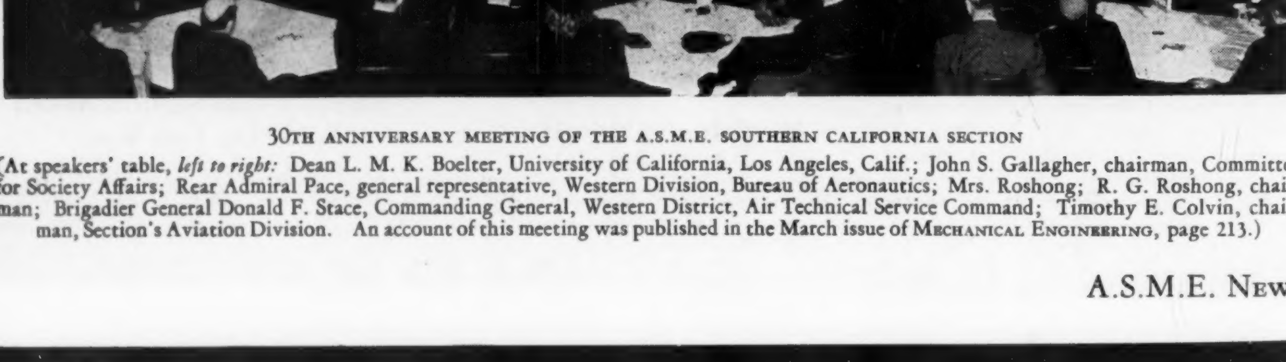
At the Feb. 8 meeting held in the P.E.P.Co. auditorium, Washington, D. C., the Section heard A. R. Stevenson, Jr., fellow A.S.M.E., of the General Electric Company discuss "Management's Educational Responsibility." In his talk Mr. Stevenson outlined management's responsibility in regard to the functioning and education of personnel and post-collegiate technical education, and spoke of the responsibilities management would have in the postwar era toward their present employees and the returning veterans. He made many excellent suggestions along these lines, one of which was that some way should be worked out whereby the returning veteran would be able to earn his living while completing his college course.

Western Washington Section Visits Isaacson Iron Works, Seattle, Wash.

On Feb. 15 the Section visited the plant of the Isaacson Iron Works, Seattle, Wash., where the members were entertained at dinner in the cafeteria, then given one of the assembly rooms for their special meeting, and finally conducted on an interesting tour through the plant. At the short meeting, Prof. E. O. Eastwood, past vice-president of the Society, presented the gold badge to John T. Heffernan for 50 years' membership in the A.S.M.E., and provided an appropriate background for thus honoring one of Seattle's outstanding senior industrialists. The careful timing of the tour through the plant, under the able guidance of Rowland Johnson and his assistants, enabled the group to see the melting, pouring, and charging operations for one of the large electric furnaces, in addition to witnessing the heavy forging and other activities. In expressing his thanks to the Isaacson Iron Works Robert L. Rockwell, chairman of the Section, said that it was one of the best attended meetings ever held.

C. A. Gladman Speaker at Worcester Section

On Feb. 5 the Section held a meeting in the Janet Earle Room, Worcester Polytechnic In-



30TH ANNIVERSARY MEETING OF THE A.S.M.E. SOUTHERN CALIFORNIA SECTION

(At speakers' table, *left to right:* Dean L. M. K. Boelter, University of California, Los Angeles, Calif.; John S. Gallagher, chairman, Committee for Society Affairs; Rear Admiral Pace, general representative, Western Division, Bureau of Aeronautics; Mrs. Roshong; R. G. Roshong, chairman; Brigadier General Donald F. Stace, Commanding General, Western District, Air Technical Service Command; Timothy E. Colvin, chairman, Section's Aviation Division. An account of this meeting was published in the March issue of MECHANICAL ENGINEERING, page 213.)

stitute, Worcester, Mass. when C. A. Gladman, scientific officer, National Physical Laboratory, London, England, read a paper entitled "Drafting Room Practice in Relation to Interchangeable Components." This paper is the result of a study and recommendations made by a special service committee on drafting practice set up by the British Admiralty. By it, basic principles are established for the guidance of designers and draftsmen when preparing drawings for interchangeable components, and logical methods of approaching solutions to dimensional problems and of stating these on drawings are discussed. Particular attention has been paid to such problems as the best method of analyzing, and dimensioning and applying tolerances to interchangeable components which involve tapered, concentric, or positional features such as holes and studs. Stress is laid upon the need for foreseeing, and avoiding as far as possible in the design stage, any special difficulties which may arise in practice in the construction of manufacturing equipment or in the construction of practical gages for controlling the dimensions of components.

With the Student Branches

California Institute of Technology Branch

For its Jan. 8 meeting the Branch had as its attraction a film "F for *Freddie*." The entire film was "shot" by the RAF and depicts the ground preparation and action of a Wellington bomber named *Freddie* on a mission over Germany.

The latest film of Allis-Chalmers was shown at the Feb. 1 meeting held on the campus. This film covered the elemental aspects of the gas turbine and showed the fundamental p-v and t-s relationships.

University of Cincinnati Branch

Plans were made for the coming term at the meeting of the Branch on Feb. 10, at the Hotel Netherland Plaza, Cincinnati, Ohio. The athletic program was discussed and plans made for a bowling and a baseball team. The meeting was especially timely as a number of the group attending expected to leave before another meeting.

Duke University Branch

On Feb. 6 at the Asbury Building, the Branch met and elected the following officers for this semester: W. H. Broadfield, president; F. W. Rowe, vice-president; J. M. Dixon, secretary; F. A. Shoemaker, treasurer. A General Electric film entitled "Railroadin'" was then shown.

University of Idaho Branch

"Unfinished Rainbows," the story of aluminum, was the film shown at the meeting on Feb. 6 at Kirtley Engineering Laboratory. On Feb. 20 two more films were shown—"Turret Lathes" and "On the Air."

Illinois Institute of Technology Branch

A regular meeting was held on Feb. 7 at Armour Branch, at which time Prof. Henry L. Nachman presented part 2 of his talk on "The History and Development of the Steam Engine." Prof. R. A. Budenholzer then led a discussion of future social functions.

A group of 150 mechanical-engineering students visited the South Works of the Carnegie Steel Corporation, South Chicago, Ill., on Feb. 15, under the sponsorship of the A.S.M.E. Branch. Upon arrival at the plant, the students were divided into groups of twenty and each group given a guide. The trip included a visit to a powerhouse of the steam-turbine type, with one reaction and several impulse types, with necessary boilers, pumps, and heat-transfer equipment; the second powerhouse visited contained the large horizontal-type reciprocating engines. Both burned blast-furnace gas. The rolling mill was in action and the groups were shown the electric-motor room. An inspection of the blast furnaces, some of which were being tapped, concluded the trip which lasted about three hours.

Iowa State College Branch

At a meeting on Feb. 15 at Memorial Union the following officers were elected for the next semester: Myron Anderson, president; Francis Murray, vice-president; Billie Dace, secretary. Eloise Heckert had previously been elected treasurer for the year. The speaker, John Ames, city manager of Ames, Iowa, was introduced by Professor Cleghorn of the mechanical-engineering department. Mr. Ames discussed the Ames city-owned electric power plant, illustrating his talk with charts. He gave the output per year, cost per kilowatt, explained how the income is spent, transfers of money to the general fund, and other related points. Members of the A.I.E.E. were guests.

Lafayette College Branch

Three films of the Johns-Manville Company were shown at the Feb. 21 meeting of the Branch at Hogg Hall, "Heat and Its Control," "When Winter Comes," and "Those Hot Summer Days." Prof. Paul B. Eaton, Branch honorary chairman, delivered a short address of welcome to the students, and John Rush, chairman, spoke briefly of the activ ties of the Branch.

Louisiana State Branch

At its meeting on Jan. 9 the Branch elected the following officers: John E. Yerger, chairman; Calhoun Sumrall, vice-chairman; Mike Fossier, secretary; and Thomas L. Aubin, treasurer.

University of Maryland Branch

The first meeting of the winter quarter was held at the University on Feb. 6 jointly with members of the A.S.C.E., A.I.E.E., and A.I. Ch.E. Motion pictures showing the drilling of oil wells and the refinement of crude oil were presented through the courtesy of the Shell Oil Company.

Joint Meeting of M.I.T., Tufts, and Yale Branches

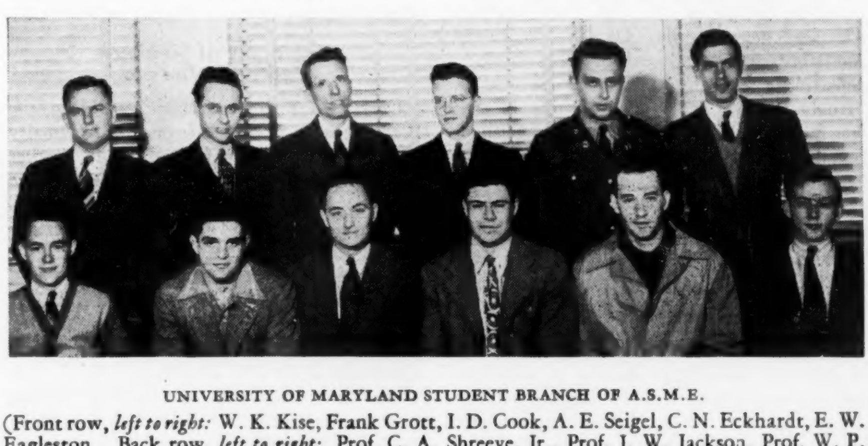
A meeting was held on Jan. 27 at the Massachusetts Institute of Technology, Cambridge, Mass., of Yale University, Tufts College, and M.I.T. Branches. Forty-two students from M.I.T. and 34 from Tufts attended. Yale was not represented.

The $30 sent by the A.S.M.E. was divided into two prizes. First prize of $20 was won by Thomas Hewson for his paper, "The Rosette Strain Calculator," and the second prize of $10 went to Warren J. Harwick for his paper "Practical Gas Turbines." Holcombe J. Brown, member A.S.M.E., of the firm of H. J. Brown, Boston, Mass., representing the Committee on Relations With Colleges, presented the prizes and addressed the assembly on behalf of the A.S.M.E.

Michigan State College Branch

In the Spartan Room, Union Building, on Jan. 17, the Branch heard L. H. Belknap, plant engineer of the Cedar Street Nash-Kelvinator Corporation, Lansing, Mich., give a short description of the Hamilton Standard Propeller, and a bird's-eye view of what a job it was to convert from a car-production plant to a gigantic plant building important parts for America's defense.

As a sequel to Mr. Belknap's talk, the Branch went to the Cedar Street plant on Jan. 31, where the plant layout was explained to them by Mr. Belknap. Then, with two other members of the staff, they were shown through the plant where the processes of production of the internal parts of the Hamilton Standard Constant-Speed Propeller were traced from rough forgings to inspected parts, and the



UNIVERSITY OF MARYLAND STUDENT BRANCH OF A.S.M.E.

(Front row, *left to right:* W. K. Kise, Frank Grott, I. D. Cook, A. E. Seigel, C. N. Eckhardt, E. W. Eagleston. Back row, *left to right:* Prof. C. A. Shreeve, Jr., Prof. J. W. Jackson, Prof. W. P. Green, A. B. Eyler, B. H. Bochenek, Barnard Lubarsky.)

PURDUE UNIVERSITY STUDENT BRANCH OF A.S.M.E., FEBRUARY, 1945

problems of the plant engineer discussed. After completing this tour, the group went to the Mount Hope plant where K. M. Comarford explained to them the problems of production of the propeller blades, and with three other members of the staff, conducted them through the plant. The complicated and painstaking processes of machining the blades to exact contours were observed and the intricate steps in final assembly and inspection.

Northeastern University Branch

At the meeting on Feb. 21 members of the Branch met with members of the other engineering societies of the University, to hear a talk by Holcombe J. Brown, member A.S.M.E., a mining engineer. Mr. Brown told of his experiences as a consultant and closed his talk with some good advice to the young engineer entering the business world.

Ohio State University Branch

A business meeting of the Branch was held Jan. 26 at Robinson Laboratory. A motion was made and carried to remove the treasury from the Ohio National Bank to the Student Auditor's Fund on the campus. The group then went to the engineering experiment station to see the Cyclotron. The Feb. 2 meeting was a business meeting only. On Feb. 9 at Robinson Laboratory, Mr. Shartle of the psychology department at the University spoke on "Analyzing Jobs and Workers." Mr. Shartle was formerly chief of the Division of Occupational Analysis under the War Manpower Commission; he was also an assistant psychologi t and member of the educational staff of the Milwaukee Electric Railway and Light Company. He has been at the Ohio State University since October, 1944.

Purdue University Branch

A film showing the development of rubber by Firestone and the production of synthetic rubber was the feature of the meeting held by the Branch in the mechanical engineering building at the University on Jan. 30. The sequence of rubber-tire production from the solid tire of the late 1800's down to the present-day pneumatic tire and tube was illustrated. On the screen a Firestone Company en ineer explained the production of synthetic rubber as it is now being carried on in large-scale production, first by the use of miniature models of the p-oductive equipment, and later illustrating the full-scale production.

On Feb. 13 the Branch showed two films, "The Birth of the B-29" and "Gas Turbines." The first film showed a complete tour of a gigantic B-29 plant and illustrated many phases of the tremendous B-29 production. The B-29 bomber was designed mainly for bombings of Japan where a long-range plane could operate from a United Nations land base rather than from aircraft carriers. With the birth of this bomber came the birth of the American 20th Air Force which mans the B-29. The film illustrating the modern regenerative gas turbine was shown through the courtesy of the Allis-Chalmers Manufacturing Company, Milwaukee, Wis. The complete regenerative cycle was illustrated and its operation, efficiencies, capabilities, and applications were explained. After the showing of the latter film, Prof. O. C. Cromer of the mechanical-engineering school, Purdue University, held an interesting discussion of the gas turbine.

University of Southern California Branch

On Jan. 31, in the engineering building, the Branch held a business meeting formally opened by President Macleod. The speaker was Dr. K. F. Venter, of the faculty, whose subject was "The Mechanical Engineer in the Industrial World." This was an interesting lecture dealing with the economies and executive duties of the engineer.

Carter Rabinoff, no ed lecturer and technical research man in the field of television, gave an illustrated lecture on television and television equipment at the Feb. 1 meeting.

On Feb. 3 a field trip, sponsored by the Los Angeles Section of the A.S.M.E., was made to the Kaiser Steel Mill, Fontana, Calif. The trip was conducted by Prof. T. T. Eyre, and attended by Prof. S. F. Duncan, Prof. V. C. George, and 23 members of the Branch. A special tour was made through the rolling mills, conducted by specialized employees in the mill. On Feb. 7 a short meeting was held for the purpose of obtaining a collection for the pictures to be published in the U.S.C. yearbook. At the Feb. 16 meeting in the Engineering Building, a group picture was taken of the Branch, dues were collected from members to pay for the plate to be used for individual pictures in the yearbook, and elections were held for the new semester, the results of which were: Kenneth Pfirrman, president; Walter W. Vickers, vice-president; John R. Nash, secretary; Michael Bealessio, treasurer; Robert Fortney, social chairman; Robert Timpson, field trips, and Clinton Yantiss, paper presentation.

University of Toronto Branch

M. J. Aykroyd, outside plant engineer of the Bell Telephone Company of Canada, and past-president of the Association of Professional Engineers of Ontario, spoke to the Branch at the meeting on Feb. 7 at the University.

He gave a brief history of the Association since its formation and went on to deal more specifically with recent developments, such as collective bargaining for engineers and the formation of an engineers' federation, an advancement which has aroused enthusiasm in the profession throughout the Dominion. He spoke of the wage scale which he had drawn up in an endeavor to obtain a guide fo the reasonable payment of engineering services. He stressed the need for youth in the organization, the average age at present being 53 years. He urged every graduating engineer to join his Provincial Association.

Tufts College Branch

The program of the Jan. 31 meeting at Robinson Hall was arranged particularly for the many members in the February graduating class who have volunteered for the Sea Bees. A Navy film was shown depicting the formation, purposes, achievements, and future of the Navy's Construction Battalion.

Virginia Polytechnic Institute Branch

Three meetings were held by the Branch in January, at Patton Hall. The first, on Jan. 8, featured a motion picture entitled "Flying Fortress." The part of this powerful plane in the present war was described in the film.

On Jan. 15, after a short business meeting at which J. W. Collins was elected assistant chairman, Mr. Collins gave an interesting talk on the "Logan Steam Station" in West Virginia, a power plant which produces one million pounds of steam an hour.

The feature of the Jan. 29 meeting was a talk by F. F. Fisher on Diesel engines. Mr. Fisher worked for several years with Diesel engines and was enthusiastic about their operation. A discussion period followed.

Yale University Branch

Interesting papers were read at the Branch meeting on Feb. 6 by W. U. Braithwaite, "The Miniature Camera;" R. P. Carroll, "Bomber Strategy;" J. McFarland, "Model A Ford;" R. P. Martin, "The Halifax Disaster;" and E. Mioduszewski, "The Military Railway Service."

U. of Maryland Announces Martin Gift for Aeronautics

DEAN S. S. Steinberg, college of engineering, University of Maryland, has announced the acceptance by the University of an initial gift of $1,700,000 from the Glenn L. Martin Company, for the establishment of a college of aeronautical education and research and the endowment of the Glenn L. Martin Aeronautical Research Foundation, both expected to exceed anything of their kind in the world.

For construction of facilities $1,500,000 of the total amount will be spent, and it is understood that Mr. Martin expects to add to this in the future. In addition, President H. C. Byrd of the University says that $750,000 in State funds will be added for construction work, making a total of $2,225,000. The remaining $200,000 will be used at the outset to endow the Glenn L. Martin Aeronautical Research Foundation.

Brown to Expand Engineering Laboratory

PRESIDENT Henry M. Wriston of Brown University, Providence, R. I., speaking at the 33rd annual dinner of Brown engineering alumni at Midston House, New York, N. Y., Jan. 19, 1945, announced the expansion of the engineering laboratory facilities at Brown made possible by a gift of $30,000 from the Hammel-Dahl Company, manufacturers of automatic control equipment, Providence, R. I. The gift was made by Hammel-Dahl Company "in appreciation of the many services and facilities made available to us by the University in the performance of our Government contracts during the year 1944 and particularly in appreciation of the courtesies shown to us by Prof. Leighton T. Bohl, '13, of the Brown Division of Engineering." A second floor will be added to the Engineering Laboratory Building as a result of this gift.

Institute of Industrial Research Established at Louisville

THE Board of Trustees of the University of Louisville has established a nonprofit corporation, The University of Louisville—Institute of Industrial Research.

The purpose of the Institute is to engage in engineering and scientific research for industrial and private clients on a contract basis.

The Institute is the outgrowth of the Division of Industrial Research in the Speed Scientific School, which during the past few years has carried on limited contract research for industry.

The new organization, in addition to employment of a small permanent technical staff from different scientific and technical fields, will depend for its assistance in supervision on selected staff members of the engineering and scientific faculty. The research work will be carried on by graduate fellows.

The Institute will be housed in a new research buildingand, in addition, will use facilities of the Engineering Laboratories.

The officers of the new Institute are:

Chairman of the Board of Managers, Dr. E. W. Jacobsen, president, University of Louisville.

President, F. L. Wilkinson, Jr., member A.S.M.E., dean, Speed Scientific School.

Director and vice-president, Dr. R. C. Ernst, professor of chemical engineering.

Scholarships for Foreign Students at Michigan Tech

TWENTY-FIVE additional scholarships for foreign students are available at the Michigan College of Mining and Technology as the result of recent Board of Control action. The scholarships entitle holders to the privileges of the college without payment of matriculation and tuition fees. They are open to properly prepared and accredited students from any country. Thus they supplement the scholarships offered since Michigan Tech was founded sixty years ago—one scholarship for each province of Canada and for each Latin-American nation. The new arrangement allows more than a single scholarship from each such province or country, and also aids men from other parts of the world. Foreign students now attending Michigan Tech come from Bolivia, Brazil, Chile, Ecuador, Peru, and Turkey.

I.I.T. Organizes Mechanics Laboratory

ORGANIZATION of a mechanics and aeronautics research laboratory to carry on long-time fundamental research in the field of solid and fluid mechanics has been announced by Illinois Institute of Technology, Chicago, Ill.

The laboratory will work in close cooperation with the mechanics and civil-engineering departments and with Illinois Tech's Armour Research Foundation.

Dr. L. H. Donnell has been named director of the laboratory and Dr. LeVan Griffis, associate director. Both also serve as teachers of mechanics at Illinois Tech.

An advisory council, representing industry, engineering societies, and certain governmental agencies, has been formed. Participating are H. C. Boardman, head of research for the Chicago Bridge and Iron company; Dr. W. F. Durand, chairman of the National Research Council's Division of Engineering and Industrial Research; Dr. J. N. Goodier, chairman of the applied-mechanics department at Cornell University; Dr. G. W. Lewis, director of aeronautical research for the National Advisory Committee for Aeronautics; Prof. H. F. Moore, research professor of engineering materials at the University of Illinois; Dr. A. Nadai, consulting engineer for the Westinghouse Electric and Manufacturing company; and Dr. S. Timoshenko, professor of theoretical and applied mechanics at Stanford University.

Honors Awarded by Stevens Institute

THE first presentation of a newly established honor award for "notable achievement" was made on Feb. 16, 1945, to nine distinguished engineers and industrialists by the Alumni Association of Stevens Institute of Technology at its annual dinner held at the Hotel Astor in observance of the 75th anniversary of the granting of the charter to the College by the State of New Jersey.

Dr. Harvey N. Davis, past-president A.S.M.E., president of Stevens, presented the awards for the Alumni Association, on behalf of the Board of Trustees of the College.

The seven medalists who are alumni of Stevens are: John V. B. Duer, '03, chief electrical engineer, Pennsylvania Railroad, Philadelphia, Pa.; John C. Hegeman, '05, president, Hegeman-Harris Co., Inc., of New York, Henry C. Meyer, Jr., '92, member A.S.M.E.; president, Meyer, Strong and Jones, Inc. of New York; William G. Mixer, '09, superintendent of foundries, Buick Motor Division, General Motors Corp., Flint, Mich.; Auguste G. Pratt, '03, member A.S.M.E., president, The Babcock & Wilcox Company of New York; Philip D. Wagoner, '96, member A.S.M.E., president, Underwood-Elliott Co. of New York; and Harry T. Woolson, '97, member A.S.M.E., president, Chrysler Institute of Engineering, Highland Park, Mich.

The other two award recipients are: Edward W. Isom, vice-president, Sinclair Refining Co., and president, Sinclair Rubber, Inc., of New York; and Raymond R. Machlett, president, Machlett Laboratories, Inc., Springdale, Conn.

The medallions, designed by Albert D'Andrea, sculptor, are made of silver and are three inches in diameter. On the face of the medal is a bas-relief impression of the first steam locomotive, which was constructed in 1826 by Colonel John Stevens, father of Edwin A. Stevens, founder of the Institute, and the inscription: "Stevens Honor Award." On the back, the medal carries the words "Stevens Institute of Technology" around the rim, with the center inscription "For Notable Achievement to" and the name of the recipient.

The presentation of an annual Alumni medal also took place at the dinner. It was given for 1945 to Robert C. Post, of Post and McCord, New York, in "recognition of outstanding loyalty and devotion to the College."

Whittle Made Honorary Member I.M.E.

ON Dec. 15, 1944, Air Commodore Frank Whittle, British pioneer in jet-propelled aircraft, was made an honorary member of The Institution of Mechanical Engineers. A biographical sketch of Commodore Whittle's career, delivered by the Secretary of the Institution, appears in the *Journal* for February, 1945, from which the following is quoted:

The Secretary said that Frank Whittle was born on 1st June 1907 in Coventry. He left Leamington College in 1923 to be a Royal Air Force aircraft apprentice at Cranwell where he was trained as a fitter rigger and in the elements of mechanics, aerodynamics and heat engines. During this period he made some remarkable model aircraft. At the end of the course he was awarded a cadetship and passed to the Royal Air Force College at Cranwell as a flight cadet. There he was trained as a pilot and his aeronautical education on both the practical and theoretical sides was continued. On passing out in 1928, he was awarded the Abdy-Gerrard-Fellows Memorial Prize for aeronautical sciences. After fifteen months in a fighter squadron as a pilot officer, in 1929 Whittle qualified as a flying instructor at Wittering. It was whilst he was there that his ideas crystallized for an internal-combustion turbine jet-propulsion engine for aircraft, and his first patent is dated 16th January 1930.

He proceeded in 1930 to the Flying Training School at Digby as a flying instructor and in that year, at the Royal Air Force Display, gave one of the best exhibitions ever seen of "crazy flying." In 1931 and 1932 he was a test pilot at the Marine Aircraft Experimental Establishment at Felixstowe and qualified as a flying boat pilot. There he took part in some noteworthy catapult and ditching trials. From 1932 to 1934 he was on the Officers' Engineering Course at Henlow, and as his performance there was quite exceptional he was sent, in 1934, to Cambridge University where in two years he obtained First-Class Honours in the Mechanical Sciences Tripos, taking four subjects in Group B in place of the two alone required.

From 1930 he had been developing his scheme for a jet-propulsion engine more and more seriously. The idea of the gas turbine was not new. The idea of jet propulsion was not new. Whittle's great contribution was to associate the two. In a postgraduate year at Cambridge devoted to research under Professor Sir Melvill Jones, he worked intensively on his scheme, and in 1936 Power Jets, Ltd., was formed, which has since become renowned as the pioneer in jet propulsion.

This small company ordered an engine to Whittle's personal design, which demonstrated the basic soundness of the gas-turbine jet-propulsion engine, and more advanced designs were put in hand. In 1938 financial support for the Power Jets experiments was forthcoming from the Air Ministry, and in that year the Ministry decided to order an experimental aeroplane. Previously Whittle had been placed on the Special Duty List to work on his engine, and the power plant of the experimental aeroplane was to his design and was built by the British Thomson-Houston Company. The Gloster Aircraft Company designed and built the airframe in close co-operation with Power Jets, Ltd., and Whittle. The result was an elegant little machine, which flew with great success in May 1941. Unless German efforts were further advanced at that time than our present knowledge leads us to believe, this was the first gas turbine-jet propulsion aeroplane to fly. These initial achievements were landmarks in engineering history and Whittle's name will rank very high in the list of British engineers. He has remained attached to the Power Jets organization which passed to Government ownership on April 28th of this year, when Air Commodore Whittle offered to make a free gift to the nation of his interest in the concern.

He was awarded the C.B.E. in the New Year's Honours, 1944, and has recently been awarded the Ewing Medal by the Royal Society and the Institution of Civil Engineers, and the Gold Medal of the Royal Aeronautical Society.

Air Commodore Whittle's pioneer work has opened up vast new possibilities in the field of aeronautics and has, in fact, already made possible speeds far in excess of those hitherto attainable. So far his gas turbine has been applied to jet propulsion for aircraft, but there are clearly other and even wider fields for it on land and sea. His work defines a distinct new landmark in the progress of the internal-combustion turbine—a step which may well rank in importance with that of Parsons on the steam turbine.

D. C. Jackson Honored on 80th Birthday

DUGALD C. JACKSON, retired professor of electrical engineering at Massachusetts Institute of Technology, Cambridge, Mass., was guest of honor at a dinner attended by 94 of his friends, on his eightieth birthday, February 13.

The speakers included President Karl T. Compton, of M.I.T., who presided, Dean J. W. Barker, of Columbia, President A. Pen-Tung Sah, National University of Amoy, China, Dean Edward L. Moreland, of M.I.T., and Prof. Harold L. Hazen and Prof. Carlton E. Tucker, of the department of electrical engineering, M.I.T.

Professor Tucker handed Dr. Jackson a collection of 174 letters, bound in hand-tooled leather, that had been received from professional societies and individuals. Seven of these letters were read, including the following which had been sent by The American Society of Mechanical Engineers:

The American Society of Mechanical Engineers joins the friends and admirers of Dugald C. Jackson in paying tribute to him on his eightieth birthday.

Dr. Jackson became a member of the A.S.M.E. fifty-four years ago and was made a Fellow of the Society in 1938. His fellow members recognize in him one of the great figures in engineering education. A pioneer in the teaching and practice of electrical engineering, Dr. Jackson has been a potent influence in the lives of many generations of engineers. Hundreds of the members of this Society have sat under his instruction and have sought his advice as a friend and as a professional consultant. He was a member of the original Committee on Education and Training for the Industries where his interest and advice was of great benefit in that new undertaking.

Dr. Jackson contributed to the understanding of the history and philosophy of the engineering profession in a series of articles published by this Society in 1938 and later reprinted in book form.

A wide range of professional experiences and a keen knowledge of human problems have made Dr. Jackson a keen student of the professional ethics of the engineer. For several years he devoted time and energy to the preparation of the Canons of Ethics submitted for the approval of the constituent bodies of the Engineers' Council for Professional Development. As a result of these untiring efforts this Society has approved the Canons in principle thus taking an important step toward greater unity and wider recognition of engineering as one of the learned professions.

It is our hope that Dr. Jackson will serve the engineering profession and this Society for many years to come and that his influence will continue to stimulate the thoughts and elevate the ideals of engineers.

Jewett Research Fellowships Awarded

FIVE Frank B. Jewett fellowships for research in the physical sciences have been awarded to Dr. Elliot R. Alexander, Dr. Albert S. Eisenstein, Dr. Kenneth Greisen, Dr. Boris Leaf, and Dr. Harry Pollard. The availability of these men to accept their fellowships will depend upon the progress of the war as each is now engaged in essential war research.

Founded by the American Telephone and Telegraph Company the fellowships are in honor of Frank B. Jewett, a vice-president of that company who retired in 1944. Each fellowship is for one year and carries a stipend of $3000, with a further honorarium to the institution where the work is done. Primary criteria are: demonstrated research ability of the applicant, the fundamental importance of the problem he proposes to attack, and the likelihood of his growth as a scientist.

Dr. Alexander received his Ph.D. from Columbia in 1944 in organic chemistry. He is presently a research chemist at the du Pont Experimental Station at Wilmington.

Dr. Eisenstein received his Ph.D. from University of Missouri in 1942, in physical chemistry. He is at present a member of the Radiation Laboratory staff at Cambridge, Mass.

Dr. Greisen received his Ph.D. from Cornell in 1943, in physics and mathematics. At present he is engaged in war work at Santa Fe, N. M.

Dr. Leaf received his Ph.D. from the University of Illinois in 1942 in physical chemistry. He is presently an associate chemist in the Metallurgical Laboratory of the University of Chicago.

Dr. Pollard received his Ph.D. from Harvard in 1942, in mathematics. Now, he is a member of the Applied Mathematics Group at Columbia University.

The Committee of Award, which consisted of mathematicians, physicists, and chemists of Bell Telephone Laboratories, considered a total of 41 applications from which the five were selected.

Mortensen Awarded Lamme Medal

SOREN H. MORTENSEN, chief electrical engineer of the Allis-Chalmers Manufacturing Company, Milwaukee, Wis., has been awarded the 1944 Lamme Medal of the American Institute of Electrical Engineers. This medal is awarded annually to a member of the Institute in recognition of high achievements in the development of electric apparatus or machinery.

Mr. Mortensen receives the medal "for his pioneer work in the development of self-

starting synchronous motors and for his contributions to the development of large hydraulic and steam-turbine-driven generators."

The Lamme Medal was established through a bequest of Benjamin Garver Lamme, who was chief engineer of the Westinghouse Electric and Manufacturing Company from 1903 to his death in 1924. He provided also for a medal to be awarded by the Society for the Promotion of Engineering Education for accomplishment in technical teaching or advancement of the art of technical training, and for a medal to be awarded by the Ohio State University, from which he was graduated in 1888, to a graduate of that university for meritorious achievement in engineering.

Zay Jeffries Receives Powder-Metallurgy Medal

DR. ZAY JEFFRIES, of the General Electric Co., Pittsfield, Mass., was awarded the newly established annual powder-metallurgy medal of Stevens Institute of Technology on March 8, 1945, when he delivered the annual lecture sponsored by the Powder Metallurgy Laboratory of the College.

The medal, which was presented for the first time, on behalf of the trustees by Dr. Harvey N. Davis, president of Stevens, is made entirely from powdered metals, and it is awarded for "outstanding work in the field of powder metallurgy." It will be awarded each year hereafter to the person selected to deliver the annual powder-metallurgy lecture. Dr. Jeffries was introduced by Prof. Gregory J. Comstock, director of the Powder Metallurgy Laboratory, and holder of the first full professorship in powder metallurgy to be established in the United States.

A.I.E.E. Nominations

THE National Nominating Committee of the American Institute of Electrical Engineers has nominated the following candidates for the offices becoming vacant August 1, 1945:

For President: W. E. Wickenden, member A.S.M.E., president, Case School of Applied Science, Cleveland, Ohio.

For Vice-Presidents: (Middle Eastern District) Ernest S. Fields, vice-president, Cincinnati Gas & Electric Co., Cincinnati, Ohio; (Southern District) Herman B. Wolf, superintendent of maintenance, Duke Power Co., Charlotte, N. C.; (North Central District) L. M. Robertson, transmission and station engineer, Public Service Co. of Colorado, Denver, Colo.; (Pacific District) F. F. Evenson, consulting engineer, San Diego, Calif.; (Canada District) F. L. Lawton, assistant chief engineer, Aluminum Company of Canada, Montreal, Canada.

For Directors: John M. Flanigen, distribution engineer, plant accounting, Georgia Power Co , Atlanta, Ga.; J. R. North, assistant electrical engineer, Commonwealth & Southern Corp., Jackson, Mich.; W. C. Smith, Pacific district engineer, General Electric Co., San Francisco, Calif.

For National Treasurer: W. I. Slichter, fellow A.S.M E., professor emeritus of electrical engineering, Columbia University, New York, N. Y.

1945 National Fire Codes Available

A REVISED edition for 1945 of the National Fire Codes for Flammable Liquids, Gases, Chemicals, and Explosives is now ready for distribution, superseding the volume published in 1943. This 592-page volume appears at a time when war demands are for increasingly larger quantities of these materials. The book assembles for the convenience of the reader the many standards dealing with these hazards, contains up-to-date information on new chemicals and solvents used in war industries, and six new or revised codes. The volume is divided into nine parts as follows: Flammable-liquid storage and handling; oil- and gasoline-burning equipment; liquefied petroleum gases; utilization of flammable liquids; gases; refrigeration and fumigation; explosive and nitrocellulose materials; tables of properties—hazardous chemicals, flammable liquids; flash-point tests. It contains many tables and drawings; page size 6 × 9 in., bound in red cloth covers. Copies may be obtained from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

A.I.M.E. Awards

THE American Institute of Mining and Metallurgical Engineers has announced the following awards:

James Douglas gold medal to Dr. Robert F. Mehl, director of Metals Research Laboratory, Carnegie Institute of Technology, Pittsburgh, Pa.

Robert W. Hunt silver medal and certificate to E. Chester Wright, chief metallurgist and assistant to the president, National Tube Company, Pittsburgh, Pa.

J. E. Johnson, Jr., award to Carl Gustav Hoberg, assistant to the chairman, Blast Furnace Committee, U. S. Steel Corporation of Delaware, Pittsburgh, Pa.

The Institute of Metals Division award to W. M. Baldwin, Jr., chief metallurgist, Chase Brass and Copper Company, Euclid, Ohio.

O.P.R.D. Solicits Projects To Speed War Effort

THE Manufacturing Engineering Committee of The American Society of Mechanical Engineers solicits the co-operation of industry in the development of projects that will speed up the war effort. The development of such projects sometimes is prevented or delayed by want of research facilities and funds. Under certain conditions, both facilities and funds can be provided through the Manufacturing Engineering Committee.

The War Production Board, through the Office of Production Research and Development, is using The American Society of Mechanical Engineers as a clearing house by which proposed projects can be analyzed and screened. The War Production Board, Office of Production Research and Development, looks to this Committee for recommendations relative to projects which it should finance in furthering the conduct of the war.

Address all communications to Mr. Richard B. Smith, Executive Secretary, 40 West 40th Street, New York 18, N. Y.

Belknap to Head Engineering at Rochester

THE appointment of Lieut. Col. John H. Belknap, at present on duty with the Army Air Forces in Washington, D. C., as chairman of the University of Rochester's newly established Division of Engineering has been announced by Dr. Alan Valentine, president of the University.

Colonel Belknap will occupy the Yates Professorship of Engineering formerly held by the late Prof. Joseph W. Gavett Jr., chairman of the University's former department of engineering until his death in 1942. He also will serve as professor of electrical engineering.

Under the new Division of Engineering plans, a four-year course in electrical engineering will be introduced, in addition to the present accredited programs in chemical and mechanical engineering.

New S.M.A. "Technical Manual"

STOKER Manufacturers' Association has announced the publication and release of their new S.M.A. "Technical Manual on Industry Standards, Recommended Practices and Technical Information." This manual is a compilation of fundamental stoker engineering and technical data which have been developed by the Association over a period of years. The manual contains 60 pages, $8^1/_2$ × 11 in., paper-bound, and the inside pages are punched for filing in loose-leaf manuals and reference books. Copies of the manual are available from the Stoker Manufacturers' Association, 307 North Michigan Ave., Chicago 1, Ill.

Reading List for Junior Engineers Available

A REVISED "Reading List for Junior Engineers" has been issued by the Junior Committee on Professional Training of the Engineers' Council for Professional Development and is now available for distribution. The reading list, reprinted in a convenient form from the Twelfth Annual Report of E.C.P.D., is a revision of the original 1936 list which has been prepared by a committee of which F. J. Van Antwerpen was chairman. It covers natural science, philosophy, including religion, economics and sociology, psychology, business and industrial management, literature, including poetry, essays, and fiction, history, biography, travel, and the fine arts.

The committee "has striven to eliminate textbooks, encyclopedic works, and volumes difficult to obtain." Modern "best sellers" have also been eliminated, but each year the committee plans to include, in mimeographed form, an addition to the printed listing, with five current best sellers. After five years on the addenda a book will be eligible for transfer to the master reading list or for elimination and discard.

In preparation of the list the "guiding of the

young engineer to proper and competent sources of cultural and intellectual fields outside of the specific profession," has been foremost in the minds of the committee. It is felt that "each selection answers admirably the main purpose of the list, namely, to serve as an introduction to vast territories of human achievement and to interest the junior engineer in fields that may be explored with attendant cultural profit." It has been assumed that most engineers will know the great and familiar works of literature and religion, such as Shakespeare's plays, Milton's poems, the Bible, and the novels of such authors as Dickens, Stevenson, and Mark Twain.

Copies of the "Reading List for Junior Engineers" may be obtained by addressing the Engineers' Council for Professional Development, 29 West 39th St., New York 18, N. Y.

Standards Advisory Committee Meets

A COMMITTEE of eight industrial executives with Charles E. Wilson, president of the General Electric Company, as chairman has been appointed by the Secretary of Commerce to advise the Department of Commerce and the American Standards Association on future plans for standards work. This appointment is the first action to come out of a conference of 50 business leaders held in New York, N. Y., on January 12 at the invitation of the Secretary of Commerce to make recommendations to him in regard to the relative roles which should be played by Government and industry in standards activities.

Serving with Mr. Wilson on the committee are Frederick M. Feiker, dean of engineering, George Washington University; Clarence Francis, chairman of the board, General Foods Corporation; Ephraim Freedman, R. H. Macy & Company, Inc.; Frank B. Jewett, president, National Academy of Sciences; William B. Warner, president, McCall Corporation; Arthur D. Whiteside, president, Dun & Bradstreet, Inc.; and R. E. Zimmerman, vice-president, U. S. Steel Corporation.

The Conference, presided over by Wayne C. Taylor, Under Secretary of Commerce, recommended that industry should provide a strong leadership in the development of national standards and that this should be done in full co-operation with the Government. In a formal resolution it expressed the opinion that "the rapid growth of standards activities, their extension into new fields, and the bearing of standards upon production and sale all make it important for top management to give attention to this matter and to provide for its orderly development."

The Conference noted with approval steps already taken by the American Standards Association to broaden the scope of its work to enable it to deal with any standard or standards project that deserves national recognition, whether in the field of engineering or consumer goods. It recommended, however, that arrangements be made for broader participation of industry— both organized groups and individual companies—in the work of the American Standards Association.

Much of the discussion in the Conference was devoted to standards for consumer goods, it being the general view that the postwar years would see extensive developments in this field.

Enemy-Owned U. S. Patents Now Available

THE publication of two sets of abstracts or short descriptions of 45,000 alien-owned U. S. patents seized by the Alien Property Custodian of the United States Government has been announced.

The patents cover practically every field of manufacture. Licenses to most of these patents are available to American citizens at a nominal fee of $15 per patent and are good for the life of the patent.

To help find items of particular interest, the abstracts have been classified and indexed. The mechanical and electrical abstracts (about 37,000 patents) consist of a short description and an illustrative drawing. The chemical abstracts (about 8000 patents) consist of a condensed description of the chemical principle involved.

The set of the mechanical and electrical abstracts is bound in four volumes comprising approximately 4000 pages and includes a 48-page index. The set of chemical abstracts in 33 sections, contains about 2000 pages and has a 400-page index. Each set of abstracts sells for $25 and may be obtained from the Office of Alien Property Custodian, 311 Field Building, Chicago 3, Ill.

If the complete sets of abstracts are not desired, portions of them (sections or classes dealing with any one subject) are obtainable at proportional cost. An index showing the section or class titles and prices may be obtained free of charge.

Joint A.S.M.E.-S.A.F. Committee on Forest-Fire Prevention

AS a result of a joint session at the 1944 Annual Meeting of the A.S.M.E. Wood Industries Division and the Society of American Foresters, the latter Society wishes the A.S.M.E. to set up a joint committee "to further the manufacture and use of improved forest-fire prevention and fire-fighting equipment."

At its meeting of Feb. 23, 1945, the Executive Committee of the A.S.M.E. Council approved the joint committee recommended and appointed its representatives and alternates to serve on the Committee. The A.S.M.E. representatives are: Henry S. Jones, Lakeland, Florida, Henry F. Kurtz, Rochester, N. Y., Edwin H. Brown, Milwaukee, Wis., as alternate, and Forest Nagler, Milwaukee, with R. K. Price, Milwaukee, Wis., as alternate.

Representatives of the American Society of Foresters on the Committee are: David, P. Godwin, assistant chief, Division of Fire Control, U. S. Forest Service, Washington, D. C., E. J. Vanderwall, director of conservation, Wisconsin Conservation Department, Madison, Wis.; and Charles S. Cowan, chief forest-fire warden, Washington Forest Fire Association, Seattle, Wash.

The purpose and objective of the committee were outlined in an article in MECHANICAL ENGINEERING for March, 1945, pages 157–160, and the need for professional-engineering aid in development of equipment for fighting forest fires was presented.

E. A. Pratt to Direct A.S.A. Inter-American Development

EDMUND A. PRATT has joined the staff of the American Standards Association to assume direction of its Inter-American Department. This department was set up about two years ago to implement a program of Inter-American co-operation in standardization, and since that time has succeeded in establishing close collaboration with the national standardizing bodies of Brazil, Mexico, Argentina, and Uruguay, and with technical groups in other countries interested in industrial and technical standards.

R.W.M.A. Elects Eisler

AT their January meeting in Detroit, Mich., the Resistance Welder Manufacturers' Association elected Chas. Eisler, member A.S.M.E., president of the R.W.M.A. for 1945.

A.S.M.E. Local Sections

Coming Meetings

Baltimore. April 23. Engineers' Club of Baltimore at 8:15 p.m. Subject: "Air Lines Plan—Their Future," by Louis P. Marechal, district manager, Transcontinental and Western Air, Inc., Washington, D. C.

Bridgeport. April 12. Hotel Barnum, Bridgeport, Conn., dinner at 6:45 p.m.; lecture at 8:00 p.m. Subject: "High-Speed Milling," by Paul Duboscland, president, Paragon Research, Inc., Buffalo, N. Y.

Central Illinois. April 12. Jefferson Hotel, Peoria, Ill., at 7:30 p.m. Subject: "President's Night," with Alex D. Bailey, president of The American Society of Mechanical Engineers. There will be a business meeting for the election of officers for 1945–1946 before the meeting.

New Haven. April 11. Mason laboratory, Yale University at 8:00 p.m. Subject: "Stresses" (in weldments), by Prof. Henry Lepper, of the Yale Engineering School, New Haven, Conn.

Ontario. April 12. Hart House, University of Toronto; dinner at 6:15 p.m.; meeting at 7:30 p.m. Subject: "Steam-Boiler Development," by W. A. Osbourne, vice-president and general manager of The Babcock & Wilcox & Goldie McCullough, Ltd., Galt, Ontario, Canada.

Plainfield. April 18. Park Hotel, Plainfield, N. J., at 8:00 p.m. This will be the Annual Meeting of the Section.

Schenectady. April 5. Hotel Van Curler at 8:00 p.m. Subject: "Tomorrow's Locomotives," by J. E. Davenport, vice-president in charge of engineering, Development and Research, American Locomotive Company.

West Virginia. April 24. Daniel Boone Hotel, Charleston, W. Va., at 8:00 p.m. Subject: "A New Welding Process at Low Temperature," by Bent Laune, who is eastern sales manager, Eutectic Welding Alloys Company.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative, nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

New York	Boston, Mass.	Chicago	Detroit	San Francisco
8 West 40th St.	4 Park St.	211 West Wacker Drive	109 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

Mechanical Engineer, age 35, with 10 years' experience in production management, planning, scheduling, expediting, inspecting, inventory control, production control, customer contact, procurement, desires position as management engineer or as sales engineer. Me-897.

Mechanical Engineer, 33, married, experienced master mechanic, shop superintendent, Navy teacher for machinists, hydraulics. Available immediately. Me-898-441D1.

Mechanical Engineer, experienced, age 42, M.E. degree and advanced postgraduate training; 18 years in responsible positions with large manufacturer of electrical and mechanical products; 4$^1/_2$ years' experience with newest types of aircraft power plants; will consider attractive propositions in postwar enterprises. Me-899.

POSITIONS AVAILABLE

Plant Engineer, 35–45, mechanical preferred, to direct plant engineers. Duties include over-all supervision of maintenance of plant equipment and milk-processing equipment; supervision and control of operations of boiler and engine rooms including refrigeration; installations of equipment with necessary piping and power wiring. Permanent. $3900–$5200 year. New York, N. Y. W-5051.

Director of Engineering, about 50, with engineering as well as general management experience. Will head engineering division as well as management of engineering subsidiary of large company manufacturing heavy equipment. Will be responsible for plant layout, product, and equipment design. $25,000 a year. Ohio. W-5054.

Mechanical Engineers, fairly young, for product, process, layout, and developmental engineering on various alloys of copper and brass with some steel working. Men with metalworking experience who have backgrounds in one of these fields would be desirable. Permanent. $4191 year on 48-hour week basis. Connecticut. W-5065.

[1] All men listed hold some form of A.S.M.E. membership.

Machine-Shop Superintendent, 35–50, thoroughly familiar with modern methods of tooling, operation, planning, and handling men. Considerable practical experience required. Postwar opportunity. $4800–$5100 year plus 5 per cent cost-of-living bonus. Delaware. W-5070.

Engineers. (*a*) Forge shop general foreman with all-round forging experience on pierce and draw work, preferably on shells. Responsible for operation of entire forge department, three shifts; nicking and breaking furnaces, presses, etc. (*b*) Machine-shop general foreman with general factory and machine-shop experience for operation of entire machining, heat-treating, banding, and painting. (*c*) Chief inspector with all-round machinist experience, preferably with toolmaking background and ability to organize. Shell-inspection experience preferred. (*d*) Maintenance foreman, engineering background, experienced, for maintenance of all equipment except machine tools; operation of pump room, responsible for cleanliness in shop and handling of scrap to cars; operation of major services including air, water, steam, and electricity. (*e*) Tool supervisor, experienced, preferably in shell industry, to keep in condition all expendable tools and the facilities for reworking these tools; operation of tool cribs throughout plant, also toolrooms and tool grinding; inspection of gages. Salaries open. Connecticut. W-5072.

Engineer interested in sales engineering with some advertising and market-analysis experience for association promoting engineering standards. $6000–$7500 year. New York, N. Y. W-5078.

Industrial Engineers, mechanical or industrial engineering degree desired or equivalent in experience. Should have considerable recent experience in time study with capacity to do methods-engineering surveys, etc. Permanent. $3600–$5000 year plus overtime. Northern New Jersey. W-5087.

Manufacturing Executive, 35–45, with well-balanced education and experience in mechanical engineering and manufacturing methods, especially on metal fabrication, desirable. Should have broad, practical knowledge of machines, dies, and tools and proved record in plant management. Top-notch man. Salary open. Illinois. W-5094-C.

Mechanical Engineer, 26–45, graduate or equivalent, with 5 years' or more experience in any kind of designing and blueprint layout for industrial machinery for design and drafting experimental models of machinery, machine parts, etc., to be used for research work with possible adaptation to production. $4660 year. Upstate New York. W-5097.

Engineer, veteran, for application engineering and sales of top-ranking pneumatic conveying and allied equipment to chemical and industrial fields in Pennsylvania, Ohio, West Virginia. Permanent with good future. Headquarters, Pennsylvania. W-5103.

Development Engineer on development of small mechanical, electrical, and optical devices. $5000–$6000 year. Connecticut. W-5106.

Manufacturing Manager. Must have experience in manufacturing of metallic and nonmetallic zippers. $10,000 year. Connecticut. W-5109.

Plant Superintendent, experienced, for company manufacturing ready-to-eat breakfast cereals. Plant employs about 100 persons. Approximately $8000–$10,000 year. Massachusetts. W-5113-B.

Industrial Management Engineer. Must have considerable experience for work as resident engineer in shipyard. Shipyard experience desirable but not necessary. Work involves installation of production control and welding controls. Must have experience in development and installation of production-control procedures. $6000–$7200 year. New England. W-5114-B.

Mechanical Engineer with varied design and machine-shop experience for establishing standards program. $5200–$6500 year. New York, N. Y. W-5140.

Manufacturing Superintendent, 30–45, with pulp and paper experience to take full charge of manufacturing department of wood-pulp insulating-board plant including unloading of logs, treating, grinding, filtering, drying, etc. $4000–$5000 year. Virginia. W-5141.

Industrial Engineer with engineering and business-management education and some knowledge of accounting to work under industrial engineering head. Must have 10 years of manufacturing and administrative experience handling varied problems and activities. Will make periodic reports and submit recommendations for changes. Will also follow up the continued execution of procedures and policies approved by management and analyze existing conditions affecting manufacturing and its control with view toward improvement. $6000 year. Connecticut. W-5143.

Plant Engineer with ability to diagnose, maintain, and develop effective machinery in 8 cereal mills in this country operated by company. Pleasing personality important as man must deal with plant personnel at each of eight plants. Permanent. Up to $4200 year depending upon ability and experience. Minnesota. R-2475 (*a*).

Research Engineer for development of manufacturing processes and equipment. Company operates eight mills. Mechanical engineer desired plus some knowledge of electrical engineering and equipment. Permanent. Up to $4200 year, depending upon experience and ability. Minnesota. R-2475 (*b*).

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after April 25, 1945, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate or Junior

Ahrendsen, Lowell K., Rochester, N. Y.
Avilez, I., Mexico City, Mexico (Rt)
Bailey, Norborne F., Atlanta, Ga.
Baker, James O. (Lieut.), Stillwater, Okla.
Barrett, Robert E., Jr., South Hadley, Mass.
Belilove, Saul, Berkeley, Calif.
Belknap, Clarence E., St. Louis, Mo.
Birlik, E. (Capt.), Pasadena, Calif.
Blatchley, C. Gilbert, Upper Darby, Pa.
Bodmer, Jakob E., Trenton, N. J.
Bonner, Harold W., San Francisco, Calif.
Bradley, Charles B., Manville, N. J.
Brown, T. C., Johannesburg, S. A.
Bryson, W. D., Auburn, N. Y.
Bubb, M. J., Pekin, Ill.
Bunn, W. B., Jr., Jersey City, N. J.
Burdett, Horace H., Milford, Mass.
Burkhardt, John B., Chicago, Ill.
Capstack, E. J., Louisville, Ky.
Carley, R. Glover, Burbank, Calif. (Re)
Carlsten, Sigurd V. (Lieut.), Belmont, Mass.
Carr, Herbert, Brooklyn, N. Y.
Casey, Albert A., Shaker Heights, Ohio (Rt & T)
Coker, Robert H., Indianapolis, Ind.
Crosby, Robert W., Raymond, Maine
Crowe, John J., Jersey City, N. J.
Crownfield, A. C., Jr., Wethersfield, Conn.
Daudet, Andre Cord, New York, N. Y.
Daves, Howard W., Brookfield, Ill. (Re)
Deutsch, Robert A., Knoxville, Tenn.
Donaldson, C. S., Bradford, Yorkshire, England
Doom, Lewis G., Los Angeles, Calif.
Downes, Daniel T., Pittsburgh, Pa.
Eastman, Nathaniel, New York, N. Y.
Edwards, Hilbert E., Mansfield, Ohio
Else, Harry D., Lima, Ohio
Fagg, L. W., Tulsa, Okla.
Fletcher, Edwin H., Staten Island, N. Y.
Fomilyant, A. A., Pasadena, Calif.
Gage, Robert T., Cleveland, Ohio
Gahagen, William C., New York, N. Y.
Gerzetich, Michael Augustine, Pekin, Ill.
Halzel, George C., Dorchester, Mass.
Hannah, Robert B., Denver, Colo.
Hartwell, Thurston, Needham, Mass.
Hassell, Howard J., Salt Lake City, Utah (Rt & T)
Hays, Charles R. (Lieut.), Victoria, B. C.
Hayward, James G., Manoa, Upper Darby, Pa.
Hedman, Sverker N. F., Stoneham, Mass.
Horlander, Leo A., Jr., Louisville, Ky.
Huet, Andre P. J., New York, N. Y.
Jenney, R. H., Ashland, Ky.
Knapp, P. R., Toledo, Ohio
Kottman, Joseph J., Binghamton, N. Y.
Ku, Y. C., Chungking, China
Kuvin, Leonard, New York, N. Y. (Rt & T)
LaCrosse, E., Jr., Indianapolis, Ind.
Lamm, Earl S., New York, N. Y.
Lindemuth, R. L., Joplin, Mo.
Livingstone, J. E., Detroit, Mich.
Lubold, Justin, New York, N. Y.
Lynch, Thomas F., New York, N. Y.
Markson, Francis, New York, N. Y.
May, John W., Durham, N. C.
McCoard, A. P., Circleville, Ohio
McNew, J. T. L., College Station, Texas
Milan, Daniel A., New Orleans, La.
Minnick, LeRoy P., Jersey Shore, Pa.
Moffett, John T., Llanerch, Pa. (Rt & T)
Moore, William, Cleveland, Ohio
Murphy, Edward Ross, East Orange, N. J.
Myers, Oscar B., Jr., San Francisco, Calif. (Re)
Nicholson, James R., New York, N. Y.
Oesterle, A. L., Kingsport, Tenn.
Oliver, Owen Norman, Duncan, Okla.
Othmer, Donald F., Brooklyn, N. Y.
Owen, John M., Corning, N. Y.
Pace, Dominick M., Bronx, N. Y.
Parsons, Charles Sumner, Fairhaven, Mass.
Pietsch, Eugene H., Des Plaines, Ill.
Rand, I. J., Cincinnati, Ohio
Rao, T. Nagesha, Mysore, India
Rhodes, A. E., Parnell, Auckland, N. Z.
Richards, Allen H., Los Angeles, Calif. (Rt & T)
Richmond, J. H. M., Chester, Pa.
Robertson, R. J., Boston, Mass.
Sadik, Ramadan, Cairo, Egypt
Sandberg, Ray A., Waukegan, Ill.
Schade, Albert, III, Ambler, Pa.
Scruggs, E. L., Lancaster, S. C.
Silverman, Sol, Bronx, N. Y.
Skolnick, Raymond R., Brooklyn, N. Y.
Smith, E. Sherman, South Coventry, Conn.
Spofford, Warren A., Glen Ridge, N. H. (Rt & T)
Stephenson, Gordon C., Minneapolis, Minn.
Storm, Elmer E., Bellflower, Calif.
Sykes, Charles S., Philadelphia, Pa.
Thompson, Ernest B., Lynn, Mass.
Vogel, Arthur, Bronx, N. Y.
Walker, W. F., Los Angeles, Calif.
Wang, Z. F., China
Wangelin, Don J., Northfield, Ill.
Watson, David M., Saginaw, Mich. (Re)
Wei, Y. F., Chungking, China
Weiner, Samuel, Brooklyn, N. Y.
Welsh, M. G., Denbigh, Virginia (Rt)
Weygandt, A. S., Buenos Aires, Argentina
Wheeler, James W., Sea Cliff, N. Y.
Whittaker, Harry, Detroit, Mich.
Wiggin, Rinaldo E., Saugus, Mass.
Woolslayer, H. J., Tulsa, Okla. (Rt & T)
Worden, W. H., Kingsport, Tenn.
Yang, Dean C. Y., Chunking, China
Yang, L. O., China
Yang, S. Y., China

CHANGE OF GRADING

Transfers to Member

Bidstrup, Herluf A., Mount Vernon, N. Y.
Bolz, Harold A., Lafayette, Ind.
Crater, Myron L., Glendale, Calif.
Duer, Rufus King, Schenectady, N. Y.
Foster, Earle W., Tilbury, Ontario
Gilroy, John A., Chicago, Ill.
Huss, Harry O., Baltimore, Md.
Jones, Harlen R. E., Honolulu, T. H.
Peterson, John D. (Capt.), Merion Sta., Pa.
Saunders, Fred Q., Richmond, Va.
Schapiro, Sylvan B., Texas City, Texas

Transfer to Fellow

Ellis, James, Kingport, Tenn.

Transfers from Student-member to Junior 95

Necrology

THE deaths of the following members have recently been reported to headquarters:

Allan, William T., December 25, 1944
Baum, Karl P., Jr.*
Betts, Philander, February 5, 1945
Carpenter, Harold, December 25, 1944
Cushing, Harvey M., January 31, 1945
Dunbar, James H., December 30, 1944
Dunn, William R., November, 1944
Hagemann, John R., February, 1945
Howe, Albert W., December 2, 1944
Huson, Winfield S., February, 1945
Stewart, Reid T., January 12, 1945
Wertheim, Ferd E., February, 1945

* Died in line of duty.

A.S.M.E. Transactions for March, 1945

THE March, 1945, issue of the Transactions of the A.S.M.E., which is the Journal of Applied Mechanics, contains:

TECHNICAL PAPERS

- Bending of Curved Thin Tubes, by Leon Beskin
- The Structural Efficiency of Wing Covers, by A. F. Donovan, Martin Goland, and J. N. Goodier
- Yielding and Fracture of Medium-Carbon Steel Under Combined Stress, by E. A. Davis
- Temperature Measurements in High-Velocity Air Streams, by H. C. Hottel and A. Kalitinsky
- A New Design Criterion for Wire Rope, by D. C. Drucker and H. Tachau
- Measurement of Torque Transmitted by Rotating Shafts, by B. F. Langer
- Network- and Differential-Analyzer Solution of Torsional Oscillation Problems Involving Nonlinear Springs, by C. Concordia
- The Axial Vibration of Turbine Disks, by A. M. G. Moody

DISCUSSION

- On previously published papers by G. Horvay and J. Ormondroyd; R. P. Kroon; and W. E. Young

BOOK REVIEWS

• Keep Informed . . .

Announcements in this section are supplied by current advertisers in MECHANICAL ENGINEERING and A.S.M.E. MECHANICAL CATALOG. This section is restricted to these advertisers.

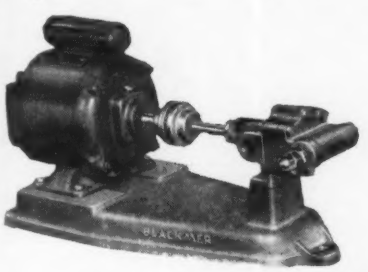
• *NEW EQUIPMENT*
• *BUSINESS CHANGES*
• *LATEST CATALOGS*

Available literature may be secured by addressing a request to the Advertising Department of MECHANICAL ENGINEERING or by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as a source.

• *NEW EQUIPMENT*

New Portable Pumping Unit

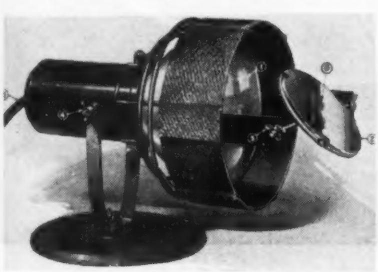
To meet the requirements of manufacturing plants, petroleum bulk station operators and other applications where temporary pumping facilities are needed, and for use by the Armed Forces, "Blackmer" engineers have developed a self-contained rotary pumping unit powered by a Wisconsin gasoline engine.



The unit illustrated consists of a 90 GPM bronze fitted standard "Blackmer" pump with built-in chatter proof relief valve, oil immersed drive and 2 HP gasoline engine, all mounted on a fabricated steel base which is fitted with telescopic handles for convenience in moving. The complete unit weighs 330 pounds and is easily carried by two men.

According to J. B. Trotman, General Sales Manager of Blackmer Pump Co., Grand Rapids 9, Mich., the new units are now in production and deliveries are currently being made.

A New Inspection Lamp



The inspection of inside surfaces of many products in process of manufacturing has always been a slow, tedious job. A new product just perfected and placed on the market, known as the McGill Inside Inspector Lamp, brings the inside "outside." The inspection of shells, cavities, castings, tubes and other objects with a deep opening is made easy with this new lamp. Burrs, grease and defects cannot escape attention. It is not necessary for the inspector to squint or strain, as the inside of the article being inspected is brought out clearly in the adjustable mirror.

A strong light is thrown inside the cavity, where the light is needed—not in the eyes—and the operator simply adjusts the mirror to a point where he can see clearly without assuming a bent or cramped position, and completes the inspection without undue eye strain. This new product designed and produced by the McGill Manufacturing Co., Inc., of Valparaiso, Ind., is known as their No. 7500 Inside Inspector Lamp. (see illustration). It has a 100 Watt, 120 Volt rating, and comes complete with a No. R-40-Spotlight installed, adjustable mirror, 12 foot insulated cord and plug, adjustable wing nuts to allow for tilting light, also for mirror adjustment—ready to plug in any light socket for immediate use. With this light a more definite and complete inspection can be made at a saving in time and worker fatigue.

Grinding Die Chasers

Miss Selma May, of the Tool Service Division at General Electric's Pittsfield Works, suggested the installation of an obviously feminine attachment—a mirror—on a die chaser grinding machine. The results were very satisfactory.

Before the mirror was put into use, the machine operator would have to remove the chaser to check the progress of the grind, and then replace it. The mirror is in a metal holder attached to the cover of the cup grinding wheel, opposite the chaser being ground. This placement reveals the progress of the work to the operator.

The mirror idea saves one minute per chaser in grinding, in addition to obtaining the correct angle of grind more easily.

New Large Size Insulating Fire Brick

A large size Insulating Fireblok is being produced by Johns-Manville, 22 East 40th St., New York, N. Y. This addition to its line of insulating refractory linings, is similar in composition and properties to the four well-known J-M Insulating Fire Brick and is suitable for the same range of temperature conditions. But one Fireblok will cover more surface than five full sized Fire Brick.

The new Fireblok is manufactured in sizes—9″ x 24″, 9″ x 12″, 4½″ x 24″, 4½″ x 12″. Standard Thicknesses 2½″, 3″ and 4½″ (4½″ only in JM-1620 and JM-20). Special sizes and thicknesses are available.

Johns-Manville points out that the new method of construction gives the Fireblok many advantages over the smaller sized Fire Brick units, among which may be noted:

Its large, convenient size and light weight assure fast economical installation.

It's easily cut with a saw and shaped with a rasp. Most special shapes can be either shop or field cut from standard blocks, reducing the inventory of special shapes.

The large size of Fireblok compared to the standard Fire Brick unit, materially reduced the number of joints, resulting in a thermally more efficient construction.

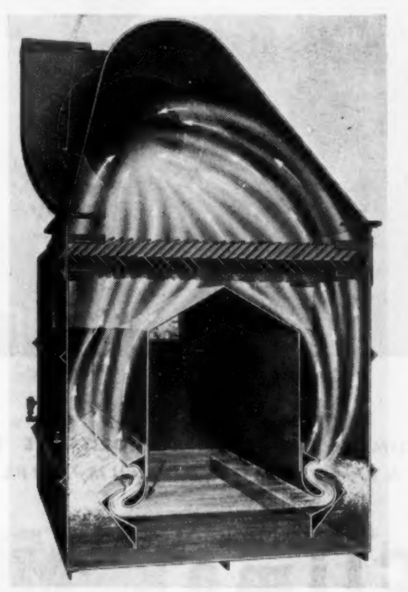
In reducing the number of joints, the Fireblok requires a minimum of mortar for bonding.

Fireblok comes in four grades—JM-1620 for exposed temperature to 1600°F., and as back-up to 2000°F.—JM-20, for use up to 2000°F., exposed or back-up—JM-23, for use up to 2300°F., exposed or back-up—JM-26, for use up to 2600°F., exposed or back-up.

Both Insulating Fireblok and Fire Brick are available for prompt shipment.

Latest Addition to Roto-Clone Series of Dust Collecting Equipment

The latest addition to the Roto-Clone series of dust collecting equipment made by the American Air Filter Co., Inc., is the Type "N" based on the principle of hydrostatic precipitation. Compact, easy to install, and requiring a minimum of space, the absence of moving parts makes it ideal for the safe control of magnesium and explosive dusts, the collection of linty and adhesive dusts from buffing operations, and the exhaust of corrosive gases.



The air is cleaned by a combination of centrifugal force and intimate inter-mixing of water and dust laden air. The air, forced through the sinuous passage of the stationary impeller, induces a heavy sheet of water to move along the surface of the impeller blades creating a water curtain in the form of a reverse "S" through which the air must penetrate. The high collection efficiency

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is the result of the impingement of the dust in water due to the centrifugal action in the impeller and the scrubbing action of the water curtain which permits returning the clean air to the workroom.

The Type "N" Roto-Clone is manufactured in three classes and thirteen sizes for the exhaust of air columns from 1,000 to 25,000 cfm. Complete details can be had without obligation by writing for Bulletin #277, American Air Filter Co., Inc., 215 Central Ave., Louisville 8, Ky.

New Double Coil Spring Lock Washers

Developed by George K. Garrett Co., 1421 Chestnut Street, Philadelphia 2, Pa., these Double Coil Spring Lock Washers have far greater reactive spring pressure than a fine lock washer, plus more resistance to shock, vibration and severe service. The Double Coil does the trick! In addition to wide general usage, they are recommended particularly on grading, bulldozing, agricultural equipment and all other types of heavy machinery.

These Double Coil Washers can be furnished in sizes for No. 4 screws up to 1" and larger bolts, in any desired finish. They are manufactured under the same rigid supervision and "Controlled Tension" principles that assure maximum quality with spring action that's long-lasting. Each washer is "torture-tested"—subjected to more severe tests than will ever be encountered in actual use.

We have also designed and manufactured double coil washers of light sections for many special uses in the electrical and allied industries.

Samples are available. Write for Bulletin 109 for illustrated data and dimensions.

Millions Saved by Welding in One Phase of Shipbuilding Program

Savings of over 2,000,000 tons of steel reported worth more than $103,000,000 in the construction of ocean-going cargo ships alone, is estimated by engineering authorities of The Lincoln Electric Co., Cleveland, Ohio, world's largest producer of arc welding equipment.

Although similar remarkable reductions in cost and material have been affected by welded construction for practically all types of ships, the above figures are estimated on the production of 3,000 deep sea cargo type vessels which have been completed by various shipyards throughout the country.

Estimates were based on figures released in a report of the United States Maritime Commission showing steel savings of approximately 821 tons per ship, which, with steel then selling at $42 per short ton, represented a cost saving of over $34,000 per hull.

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The Sun Shipbuilding Co., Chester, Pa., one of the government builders of the type of ship referred to, recently published some interesting information on their welded-ship program in a tribute to J. W. Van Dyke, late Chairman of the Board of the Atlantic Refining Co. The published statement reads in part:

"J. W. Van Dyke was the father of the deep sea all-welded ship. Without the welded ship the miracle of shipbuilding that lifted our nation from a poor fourth to the greatest sea power in the history of the world would not have been possible. Without the welded ship the miracle of quantity production and operation accomplished by the U. S. Maritime Commission would not be possible. Without the welded ship our advance to ultimate victory could not be possible."

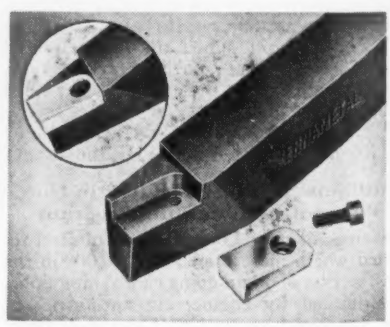
"In looking back this year, we take satisfaction in the remarkable record in launching all-welded ships. The first welded tanker, the 19,000-ton SS J. W. Van Dyke, was built by Sun Ship for The Atlantic Refining Co. as a result of Mr. Van Dyke's vision, courage and cooperation. This was the start of large ship welding technique—this was the start of the pattern for our present great merchant fleet."

Mr. Van Dyke is typical of scores of American industrial leaders who recognize the possibilities of arc welding, the process which has made possible the amazing records of our shipyards in producing all types of cargo and fighting ships in such a short time.

Not only has welding made our huge shipbuilding program possible, but it has also contributed much to the entire war production effort by helping turn out planes, guns, tanks, ammunition and similar war material in unprecedented quantities and in a limited time.

New "Screwed-on" Kennametal Tool Blanks

Kennametal Inc., of Latrobe, Pa., has developed a new type of Kennametal tool blank having a drilled and counterbored hole to provide for attachment to steel shank by means of a recessed-head cap screw. The angularly-set screw serves merely to hold the tip against the recess walls, which resist the main cutting thrusts.



These blanks are now available in several of the larger sizes, with formed clearance angles, RH or LH, and in all standard grades of Kennametal. Complete tools of various styles—straight edge, lead angle, offset, etc., can now be furnished with the screwed-on tips, or separate standard blanks will be supplied to those who wish to make their own tools. Blanks of non-standard shapes and sizes having this feature may also be had for special tools, such as are used in shell turning, form cutting of radii and grooves, etc.

The advantages of this improved design are: (1) Greater durability in use, and in grinding. (2) More consistent performance. A positive mechanical fastening dis-

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places uncertain brazed joints. (3) Opportunity of heat treating shanks to withstand the pressure of heavy cutting. (4) Simplified fastening. Only one removable element—a cap screw. (5) Removability of tip permits independent grinding of shank. (6) Streamlined design with no projection beyond shank cross-section. (7) Minimized stock requirements, as tips of different Kennametal grades can be interchanged in the same shank. (8) Simplified tool making, as most shops are better equipped to drill and tap holes than to braze joints properly.

Axial Flow Fans

A new, moderately-priced line of highly developed Axial Flow Fans is now offered for general ventilating and air conditioning service. This is the Buffalo Type "B" line, manufactured by Buffalo Forge Co., Buffalo, N. Y.

A welded steel wheel is used, with large hub and varying blade pitch to give uniform air flow over the entire blade. Large hub prevents re-entry losses common to the ordinary propeller fan.

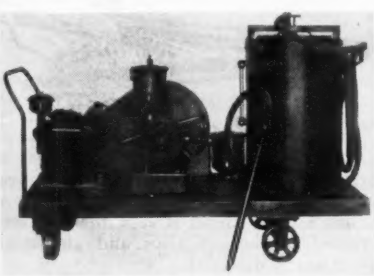
Housings are heavy gauge welded steel; rigid motor supports permit use of standard motors.

Type "B" Axial Flow Fans are offered in belted or direct connected models, in capacities up to 45,750 cfm, and pressures ranging up to 1-1/2" static. Belted models are Vaneaxial only (with stationary directional vanes) direct connected. Models Vaneaxial or Tubeaxial (without vanes), complete ratings and details of construction are contained in Bulletin 3533.

Zip! And the Liquid Residue in the Container is Gone

Industrial containers whether of metal or wood in the shape of boxes or barrels often have to be washed out for refilling.

In this cleaning and washing operation there is always the last remains of the liquid washing solution which must be quickly and definitely removed.



What better way to do this than a powerful sucking tool which may be inserted into the wet spot, which will instantly remove every last drop with unfailing certainty. Such a method is provided in the new suction outfit made by Leiman Bros. 118–79 Christie St., Newark, 5, N. J.

This outfit consists of a powerful rotary vacuum pump especially designed to create not only a high degree of vacuum but a sufficient volume of air to provide the necessary power to remove without fail this liquid residue instantly.

The vacuum pump mounted in the form of a mobile unit powered with an electric motor or, as shown in our picture, a gasoline engine, is complete ready to work with rubber hose and special suction tool. The truck is equipped with wheels and handle for moving about easily and may be used all over the plant.

The tank catches and holds the liquid residue and as it accumulates, a glass gauge

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shows the quantity, and it may be drawn off as desired by means of drain plug provided.

The vacuum pump is automatically lubricated, and there is provided a relief valve to regulate the degree of vacuum to be used.

Made in sizes for cleaning one, two, or more barrels or containers at one time and full information may be procured by writing to the manufacturer named above.

Pressure Blowers

New efficiency and new economy are outstanding characteristics of two new lines of Pressure Blowers developed by Buffalo Forge Co., Buffalo, N. Y. The unit designated as Type "CB" (Centrifugal Blower) has a capacity range from 200 to 5,000 cubic feet per minute and a pressure range from $^3/_4$ pound to 2 pounds per square inch. The Type "CC" (Centrifugal Compressor) Unit ranges in capacity from 4,000 to 75,000 cfm., at pressures up to 4 pounds per square inch.

Developed from results of vacuum pit testing, the rotors used in both these units are largely responsible for the fine performance obtained.

While both these designs are just now offered to Industry, they are actually the product of long and careful research work, climaxed by the insistance of war demands for fans of this type. Hundreds of these fans are already in use, with excellent results.

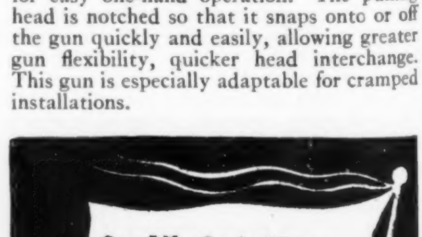
Complete data and ratings are contained in Bulletin No. 3553.

A New, Compact, Lightweight Rivet Gun

A new, compact, lightweight rivet gun, the G-36, is a recent development of the Cherry Rivet Co. of Los Angeles, Calif. Designed for installing Cherry Blind Rivets in hard-to-get-at blind spots, it is operated with one hand—installs the rivet from one side of the job, with a pulling force—eliminates the necessity of a man on the other side of the rivet.

The G-35 has already proven its ease and flexibility of use in such industries as aircraft, sheet metal, radio, marine, railroad, automotive, furniture. It is ideal for installing Cherry Blind Rivets in sheet metal, plywood, rubber, plastics and almost any soft or brittle material.

The gun is small, compact, flexible, measures only $11^1/_2$ inches in length, weighs approximately $1^1/_2$ pounds, is well-balanced for easy one-hand operation. The pulling head is notched so that it snaps onto or off the gun quickly and easily, allowing greater gun flexibility, quicker head interchange. This gun is especially adaptable for cramped installations.



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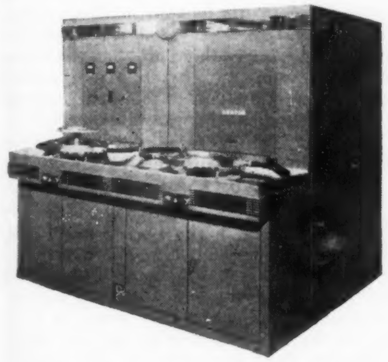
Pulling heads are interchangeable for any standard Cherry Blind Rivet, aluminum, copper or steel. The gun is inexpensive and may be purchased singly or in a special kit, Cherry Kit No. 35, along with a selection of rivets. Cherry Rivet Co., 231 Winston Street, Los Angeles 13, Calif.

New 50-Kw Electronic Heater

A new 50-kw electronic heater for surface and localized hardening of gears, rods, and other parts and for annealing, brazing, and soldering operations, has been announced by the Industrial Heating Division of the General Electric Company. Ideal for use in metal-working plants, the new heater incorporates all of the important features of the 5-kw and 15-kw G-E heaters and, in addition, is capable of heat-treating much larger parts or the same size parts in less time. This heater is readily applicable for many different heating jobs merely by changing the induction-coil fixture.



Available in models rated either 230 or 460 volts, 3 phase, 60 cycles, this heater is unusually easy to operate. The parts to be heated are positioned in the fixture, and the "start" button is pressed. Automatic controls then regulate the heating and quenching cycles, assuring duplication of results on each part. An attached work table provides two heating positions, permitting full utilization of the high-frequency power supply to secure maximum production.

Completely enclosed in grounded steel, which minimizes radiation and affords protection for the operator, the entire unit weighs approximately 6000 lb and is 84 inches wide, 94 inches deep, and 82 inches high overall. The electronic heater cabinet is composed of two compartments, one of which contains an air-cooled transformer to step-up power supply voltage to the six rectifier tubes, and such accessory items as a contactor, a tap-changing switch, and filament transformers. The other compartment contains the high frequency components—a single water-cooled oscillator tube and a bank of water-cooled capacitors. The two compartments are separated by a heavy, protecting partition. Meters and controls are conveniently mounted on the front of the two compartments, which are securely bolted together.

Stacey Brothers to Build Five Million Cubic Foot Gas Holder at Long Beach, California

The construction of a five million cubic foot telescopic gas storage holder for the City of Long Beach, Calif., has been awarded to The Stacey Bros. Gas Construction Co., one of the Dresser Industries—and steel erection will start by May 15th, it is announced by William H. Partridge, Superintendent of the Municipal Gas Department.

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The five-lift structure will be the world's largest all-welded panel type, water-seal gas holder and will provide reserve storage to meet the high peak loads which have resulted from the increased industrial activity in this area.

The Stacey Brothers vertical panel construction will be used, which permits the use of larger plates, more prefabrication, and greater ease in assembly. Fabrication will be handled in the company's Cincinnati, Ohio and Torrance, California plants.

This will be the first large gas storage holder constructed on the Pacific Coast since 1941, and priorities for the steel and allocation of the restricted materials were obtained from the War Production Board following a thorough investigation as to the essentiality of the entire project.

The very large increase in the number of consumers served by the Municipal Gas System of Long Beach has been, of course, partially due to the migration of numerous war workers now employed at the aircraft and shipbuilding plants located in this vicinity. This has created a very heavy potential demand for gas throughout the heating season and at the same time local supplies of natural gas must be conserved to meet the more essential demands of the war effort.

Revolutionary Engine Development Announced by Cooper-Bessemer

Mount Vernon, O.—A startling and entirely new development in the Diesel engine field, which will enable the engine operator to use either gas or oil as fuel without any electrical sparking device, and which will cut fuel consumption of gas engines by from 20 to 25 percent, was revealed here recently by Ralph L. Boyer, chief engineer, of The Cooper-Bessemer Corp., Diesel manufacturers.

In an interview, Mr. Boyer said that the new discovery is the result of experimentation which began in 1928. Recently efforts have been rewarded by the successful operation of a natural gas engine on the Diesel principle. This enables the unit to operate on a wide variety of fuels including fuel oil, natural gas, manufactured and coke oven gases, sewage gas, and refinery by-products.

The conversion from liquid to gas fuel is as simple as the closing of one valve and the opening of another with the engine operating continuously at full load, Mr. Boyer said. Although conversion from one fuel to another has been possible in the past, it has always been necessary to shut down and exchange major or minor parts of the engine.

The new principle will enable the engine to have the same fuel economy regardless of the type of fuel used. It raises the normal 25 percent thermal efficiency of the gas engine to the 35 percent thermal efficiency common in Diesel oil engines.

Several times since 1928, Mr. Boyer said, engineers in the Diesel field thought they had the answer to the multi-fuel conversion problem but in the past it has been thought necessary to inject the gas under high pressure of from 1200 to 1500 pounds. This involved complications which overcame the advantages obtained. The new Cooper-Bessemer development makes possible the use of gas at normal pressure and the change from one fuel to another without the necessity of a shutdown.

The significance of the new development is particularly impressive when one of our modern transcontinental pipe lines is considered. Many of these pipe lines have from 100,000 to 150,000 horsepower of gas engines installed along their length which drive the compressors or pumps that deliver the fuel to the markets of the East. The total fuel used by these

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engines for 150,000 horsepower would amount to 36,000,000 cubic feet of gas per day, which is about one-third of a single day's total consumption of a city with a population of a million.

When operating as gas engines, these new gas Diesels would save from 5,000,000 to 6,000,000 cubic feet of gas for domestic and industrial consumption per day. If these engines are converted to oil fuel—and they could be in a moment's notice, to any or all oil fuels—the total fuel consumption of 36,000,000 cubic feet of gas could be made available for consumer use.

If this new principle had been discovered some time prior to the present gas shortage, the curtailment of war production such as has been in existence in recent weeks might have been avoided.

The Cooper-Bessemer Corp., one of the largest builders of Diesel engines and gas compressors in the country, already has engines embodying the new principle in production along with their standard line of marine and stationary engines and standard compressor units.

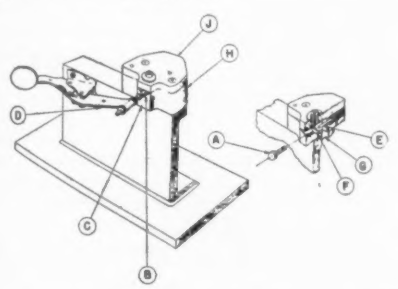
In addition to the convertibility feature and the possible fuel saving, the new development in Diesel operation will mean the elimination of one of the greatest fire and explosion hazards in the gasoline refining industry because there will be no necessity for using any ignition or sparking device.

Self-Ejecting Drill Jig

A self-ejecting drill jig has been designed and developed by Leo Malecki of the Tool Design Section at General Electric's Schenectady Works. Besides combining both simplicity and economy in design, it is very effective in increasing production and reducing drill breakage.

The part being drilled is placed in the jig, and the underside of the head of this part is located and clamped against the surface. Having been depressed by the clamping action, the springloaded pin ejects the machined part from the jig when unclamped.

The chamfer and hole in the channel in the V-block of the jig provide for the removal of chips. A fabrication of a channel and base plate is the support for the V-block and bushing plate. The base plate is of sufficient size to allow the clamping of the drill jig with the drill bushing positioned under the spindle of the drill press.



Drawing shows various sections of self-ejecting drill jig: *A*—part to be machined, *B*—jig, *C*—surface, *D*—clamp, *E*—spring-loaded pin, *F*—chamfer, *G*—hole in channel, *H*—V-block, *J*—bushing plate.

AE Announces New Car Puller

American Engineering Co., Philadelphia, manufacturers of Lo-Hed Electric Hoists, announces the introduction of their new Class $2^1/_2$ Lo-Hed Car Puller—affectionately called the "One Man Gang."

The Lo-Hed Car Puller is a husky hauling device in which the barrel, gear box and

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motor are integrated in a single, streamlined unit. Starting line pull is 5000 lbs., using a single line, or more with various block combinations.

Uses of the car puller range from hauling railroad cars of all types to pulling skids, powering boat and airplane runways, dragging logs, bending pipe and numerous other backbreaking operations where imagination sees its possibilities.

Dimensions, features and applications for the Lo-Hed Car Puller are presented in a colorful folder just released, and available by writing to American Engineering Co., Philadelphia 25, Pa.

Glass Tanks

Pittsburgh, Pa.—Almost daily in wartime the adage "Necessity is the Mother of Invention" is verified by the findings of scientific research in industry. Science is uncovering all kinds of new ways to do things disproving the idea that the old ways were better or more economical.

And the 5,000-year-old glass industry is constantly matching steps with newer products in the development of materials and equipment for commercial processes heretofore deemed unworthy of such a fragile substance as glass. On account of its brittleness glass was handicapped even though it was one of the strongest and hardest of materials.

To overcome handicaps in glass material for industrial purposes, Pittsburgh Plate Glass scientists went to work and the progress has been so rapid that the glass makers themselves haven't been able to take full advantage of scientific findings. R. A. Miller of the Company's research staff stated that more progress has been made in glass production during the past 25 years than in any other similar period in the history of the industry. Wartime research progress has been doubly rapid.

Shortly after the stunning news of Pearl Harbor, a large Eastern concern, unable to get replacements for a battery of tanks which had been corroded by acids, asked Pittsburgh Plate if glass replacements could be furnished for the emergency. Because of its brittleness glass in tanks had never been used extensively for industrial applications. With the perfection of the Herculite process by Pittsburgh, strength against breakage was boosted by four or five times.

Hence, with the manufacture of the first all-glass tank by the new heat treating process about 18 months ago, Pittsburgh found the answer to the need for industrial tanks where corrosive solutions poised a maintenance problem. With the exception of hydrofluoric acid and hot caustic, glass is impervious to acids which destroy every other type of material used in tanks. The eventual breakdown of tanks of other materials has been accepted as an inevitable plant problem. This difficulty is entirely overcome by the use of tanks made of glass.

Pittsburgh Plate Glass Co. has installed glass tanks now in several hundred plants and pharmaceutical houses and in steel mills. These tanks stand an instantaneous temperature shock of 400 degrees Fahrenheit and continuous working temperatures of from 500 to 600 degrees. Pickling and plating solutions rarely are over 250 degrees.

The Herculite glass shows great resistance to impact. A piece 12 inches square and three-quarters of an inch thick, supported only at the edges, will withstand, without cracking, the shock of having a five-inch duck-pin ball dropped on it from a height of 26 feet.

Two types of glass tanks are being produced by Pittsburgh Plate. One is made entirely of either opaque or transparent glass

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five-eighths to one and one-fourth inches thick depending on service requirements. The side walls are grooved to take gaskets of impregnated glass cloth at the joints and the tanks are held together by noncorrosive metal tie rods. The bottom has an inner or secondary lining of Herculite. The maximum inside size of such tanks is eight feet long by five feet ten inches wide and five feet deep.

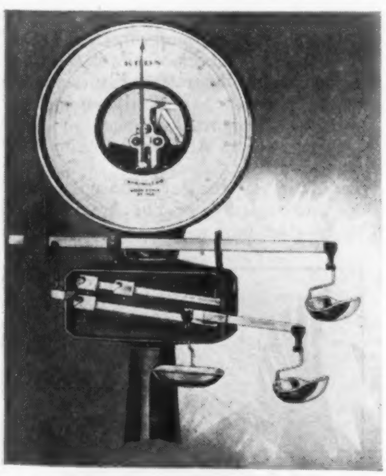
The other type has a one-half inch glass lining inside a steel shell and is used where larger tanks are required. The glass is held away from the outer shell by spacers which are designed to put pressure on the joints. The space between the glass and the outer shell contains a continuous acid resistant membrane applied by a special process. The theoretical maximum size of glass tanks of this type is limited by the size in which the glass plates can be made. This is usually nine feet by six feet by five feet.

Pyrex drains are provided for severe corrosive conditions. Tanks also have been installed with glass hoods for removing fumes and with heating units known as candle heaters. All the metal parts of these heating units are enclosed in glass.

According to Dr. J. H. Shertz, Director of the Product Development Department of the Pittsburgh Plate Glass Co., special tanks can be fabricated for practically any use. Certainly, it is well worth the effort to consider the use of glass tanks regardless of the problems involved, and specifications can be formulated for tanks for almost any specific purpose.

Stock and Inventory Control Costs Cut with Kron Counting Scales

By eliminating "overages" in shipments, maintaining a faster and more accurate control of inventory and stock, erasing needless rehandling of parts, and assuring exact quantity control of parts manufactured, "Kron" counting scales cut materials handling costs and bring a new high in accuracy to stock records. They are available in a wide variety of models to meet every counting requirement which is determined by the size, weight, and average quantity of parts to be counted. Extremely sensitive, they assure swift and accurate counting of even the smallest and most lightweight parts.



"Kron" counting scales are available in single-fixed, double-fixed and triple-fixed ratio types, and can be supplied in the following standard counting ratios to meet specific requirements: 9:1, 49:1, 99:1 and 999:1; also 10:, 50:1, 100:1 and 1000:1. These ratios can be supplied in any combination needed for the precise counting of parts of any size and weight or of any quantity.

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All "Kron" counting scales are available in dormant platform, portable platform and bench types. They also function as precision industrial weighing scales since no adjustments of any kind are needed for the change-over from counting to weighing operations.

For complete information about "Kron" industrial dial scales, write The Yale & Towne Manufacturing Co., Philadelphia Div., Philadelphia 24, Pa.

• BUSINESS CHANGES

McAlear and Hanlon-Waters Change Tradename

Hanlon-Waters, Tulsa, and McAlear Manufacturing Co., Chicago, have integrated their operations and will conduct business as the Automatic Control Division of Climax Industries, of which Climax Engineering Co. is also a division. The three companies, affiliated for the past year, have heretofore operated as separate businesses.

General management, sales and engineering are also being centered under single heads in charge of these executive functions for McAlear and Hanlon-Waters plants. Edward F. Deacon, Climax president, has announced the following new appointments: L. J. Griffey, vice president and general manager; M. C. Waterman, vice president in charge of engineering; C. W. Snyder, vice president in charge of sales.

The two plants and all Hanlon-Waters branch offices and warehouses in the mid-continent oil field are being continued. In other territories sales will be handled through distributors. Export sales will be handled by General International, Chicago.

Climax and McAlear tradenames will designate all products in the future.

Farrel-Birmingham Buys Atwood Machine Co.

Farrel-Birmingham Co., Inc., of Ansonia, Conn., and Buffalo, N. Y., manufacturer of heavy industrial machinery and equipment, has announced the purchase of The Atwood Machine Co. of Stonington, Connecticut, pioneer manufacturer of textile machinery.

This transaction unites two old and highly respected firms, bringing together nearly two centuries of experience in machine design and construction. Farrel-Birmingham's history dates back to its establishment in Connecticut's Naugatuck Valley in the year 1836, while The Atwood Machine Co. was founded in 1852.

Franklin R. Hoadley, who has been president and treasurer of The Atwood Machine Co. for the past eight years, will succeed

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John W. Haddock as president of Farrel-Birmingham Co. Mr. Hoadley has been associated with the Farrel-Birmingham firm since his graduation from Yale in 1914. He was foundry manager for a number of years, vice president from 1930 to 1936, and has been a director since 1923.

Farrell Birmingham Co. will continued to build Atwood textile machinery at the Stonington plant, and will maintain the engineering, production and sales services of Atwood's 93-year old organization. W. M. Fraser, formerly vice president, has been made general manager of the Atwood plant. No other changes in the organization are contemplated.

Foote Bros. Gear & Machine Co. Announce Election of Additional Officers

William A. Barr, President of Foote Bros. Gear & Machine Corp., Chicago, Illinois, announces the election of these additional officers of the company at a recent meeting of the Board of Directors.

L. F. Campbell, Vice-President in Charge of Manufacturing, Precision Gear Division.

R. B. Moir, Assistant Vice-President in Charge of Sales Engineering, Industrial Gear Division.

E. A. Johnson, Assistant Vice-President in Charge of Manufacturing, Industrial Gear Division.

I. C. McVicar, Assistant Secretary.

L. J. Malina, Assistant Treasurer.

The appointment of the above officers became effective February 6, 1945.

James M. Tuttle is Added to Foxboro's Pittsburgh Staff

James M. Tuttle has joined the staff of engineers attached to the Pittsburgh office of The Foxboro Co., at 5151 Baum Blvd., Pittsburgh, 24, Pa. The Foxboro Co., Foxboro, Mass., is a leading manufacturer of industrial instruments for measurement and control.

Mr. Tuttle has a background of experience which will be particularly useful in serving the diversified industries of the Pittsburgh territory. A graduate of M.I.T., he spent several years as an engineer with an industrial construction company, and later conducted his own business as a manufacturers' representative and engineering consultant.

Donald J. Reese Returns to International Nickel from W. P. B.

Donald J. Reese, who has been with the Steel Div. of the War Production Board at Washington, D. C. since April, 1942, has resumed his duties with the Development and Research Division of The International Nickel Company, Inc. at New York, T. H. Wickenden, Manager of that Division of the Company, announced.

New Centralized Administrative Offices for Dresser Industries

Cleveland—New centralized administrative offices of Dresser Industries, Inc., formerly of Bradford, Pa., were opened March 19th at 1130 Terminal Tower, Cleveland, according to H. N. Mallon, president. Planned to provide the latest and most efficient business facilities for the company's personnel, the new offices will also reduce executive travel time to the company's 18 different plants by providing a more central location for the company's headquarters.

Dresser Industries, Inc., parent corporation of 13 member companies, has laid out its 5,800 square feet of space in the Terminal Tower to provide modern conference space, reception room, and executive suites, in

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addition to 14 offices for the accommodation of its staff. Unusual construction and lighting features have been installed to add to the working efficiency of the personnel, to eliminate unnecessary maintenance, and to expedite all headquarters services to member companies.

Dresser Industries member companies include Bryant Heater Co., Cleveland; Dresser Manufacturing Division, Bradford, Pa.; Clark Bros. Co., Inc., Olean, N. Y.; Pacific Pumps, Inc., Huntington Park, California; International Derrick & Equipment Co., Columbus, Marietta, and Delaware, Ohio, Beaumont, Texas, and Torrance, Calif.; Stacey Bros. Gas Construction Co., Cincinnati; Roots-Connersville Blower Corp., Connersville, Indiana; Dresser Mfg. Co., Ltd., Toronto; Bovaird & Seyfang Mfg. Co., Bradford, Pa.; and Van der Horst Corp. of America, Olean, N. Y., and Cleveland.

Newest members of the Dresser Industries group, as recently announced, are Payne Furnace Co., and Kobe, Inc., both of California. Another company, Day & Night Mfg. Co., also of California, is now in the process of acquisition.

Consolidated New York Offices for Dresser Industries

The opening on March 15th of consolidated domestic and export sales offices for the member companies of Dresser Industries, Inc., at 800 Chanin Building, New York City, is announced by H. N. Mallon, President.

Fifteen offices, in addition to a reception room, conference room, and stenographic room, occupy 6,000 square feet of floor space and will also provide New York headquarters for visiting officers of Dresser member companies. An auditorium seating 250 persons is additionally available in the building for sales conferences and other meetings.

Modern efficiency in layout and lighting is the keynote of the space to be occupied. Equipped with every modern time-saving device for improved processing and handling of orders, the sales offices of the Dresser member companies formerly located individually throughout the New York business district will benefit by the combined facilities and central location represented in this new space. The new offices will also afford closer coordination, and be of advantage to customers and distributors interested in the related products of Dresser Industries, Inc.

Sales departments of Dresser member companies serving the fields of oil and gas from production to utilization, and represented in the newly opened New York offices, will be the Dresser Manufacturing Division, Bryant Heater Co., Clark Bros. Co., Inc., Pacific Pumps, Inc., International Derrick & Equipment Co., Roots-Connersville Blower Corp., and Stacey Bros. Gas Construction Co.

Franklin R. Hoadley Elected President of Farrel-Birmingham

Farrel-Birmingham Co., Inc., of Ansonia, Conn., and Buffalo, N. Y., announces the election of Franklin R. Hoadley as president. He assumed his new duties recently.

Mr. Hoadley has been associated with Farrel-Birmingham Co. since his graduation from Yale University in 1914. During World War I he served in this country and abroad as a lieutenant in the ordnance department. He returned to Farrel-Birmingham in 1918, became foundry manager in 1919, and in 1930 was elected vice president and a member of the executive committee. He has been a director continuously since 1923. For the

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past eight years Mr. Hoadley has been president and treasurer of The Atwood Machine Co., Stonington, Conn.

The Atwood Machine Co. has been purchased by Farrel-Birmingham Co., and Mr. Hoadley will continue general supervision of this plant, as well as assuming general management of the company's other three plants in Ansonia and Derby, Conn., and Buffalo, N. Y.

Mr. Hoadley is a director of the Southern New England Telephone Co., the Manufacturers Association of Connecticut, and a past president of the Gray Iron Founders Society and the National Founders Association. He is on the board of managers of the Westerly (Rhode Island) branch of Industrial Trust Co. and is a member of Governor Baldwin's Reconversion Committee for the State of Connecticut.

Armco Pipe Sales Appointments

Effective immediately, Armco Spiral Welded Pipe will be sold through Armco Drainage & Metal Products, Inc., Middletown, Ohio, a wholly-owned subsidiary of The American Rolling Mill Co., according to an announcement by officials of the parent company.

The new commercial arrangement consolidates all Armco pipe and fabricated product activities in one organization.

R. C. Beam has been named manager of the Welded Pipe Sales Division of Armco Drainage & Metal Products, Inc. He formerly headed the Pipe Sales Division of the parent company.

R. E. Walker has been appointed District Manager of Welded Pipe Sales and will continue to be located in Tulsa, Oklahoma. Division offices of Armco Drainage & Metal Products, Inc., are now maintained in principal cities throughout the country.

McIntosh Elected Vice President of Toledo Scale Co.

H. D. Bennett of Toledo Scale Co., Toledo 12, Ohio, announces the election of Harris McIntosh as Vice President in charge of Production and Engineering, and director.

Mr. McIntosh has had a wide range o manufacturing experience. After leaving college, he had experience in the plastics, die casting, screw machine, and paper industries. At one point, he was Production Manager of the Syracuse plant of the Electric Auto-Lite Co.

Immediately before coming here, Mr. McIntosh had been in the aircraft industry for a period of years, and at the time of his leaving, he was Assistant to the President and Director of Management Control of the Lockheed Aircraft Corp. He was associated with the aircraft companies at the time of their tremendous growth, and brings to our Company the benefit of an up-to-date knowledge of the techniques developed by that industry, whose achievements are a matter of record in the public press.

Builders-Providence Celebrated 125th Anniversary

Builders Iron Foundry, and its affiliates, Builders-Providence, Inc., % Proportioneers, Inc. % and Omega Machine Co., Providence, Rhode Island, recently held a triple celebration to commemorate the Company's 125th Anniversary, to honor 270 employees having from five to fifty-four years of service, and to celebrate the award of the Fifth Army-Navy E just received by the concern.

The Company paid honor at a dinner to two hundred seventy employees with the presentation of pins signifying five, ten and twenty-five years of service—a total of more

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than four thousand four hundred years. Harry S. Dolbey, Research and Service Man; Albert B. Coulters, New England Representative; Peter Morrison, Pattern Maker; James B. Cook, Core Maker; Charles G. Richardson, Vice President and Manager of Municipal Sales; and Thomas G. Healey, Foundry Foreman, received special congratulations, each having served over forty years.

Reciprocating in kind, the Employees of Builders presented the Company with a Service Award in the form of a giant pin studded with five diamonds to commemorate one hundred twenty-five years of continuous service by the Company. Henry S. Chafee, President and Treasurer, accepted the Award for the firm and presented the service pins to the employees. D. J. Purdie, of the New York Office, with thirty-three years service, acted as Toastmaster for the occasion.

It was pointed out that the Company, since its founding in 1820, has enjoyed consistent growth both in size and in the scope of its operations. The year 1887 ushered in an important development in Builders' history. It was in that year that Clemens Herschel developed the Venturi Tube for which Frederick N. Connet, Chief Engineer of Builders Iron Foundry, perfected the necessary instruments. The resulting "Venturi Meter" was an outstanding scientific achievement. In the years that followed, the Company expanded its activities and designed, manufactured and distributed a wide variety of flow measuring and flow controlling instruments that found applications in industry, power plants and water and sewage works throughout the world. A little more than a decade ago, Builders participated in the organization of % Proportioneers, Inc. %, for whom it manufactures constant rate and flow proportional pumps for feeding all types of chemical solutions. In the past year, Builders acquired the Omega Machine Co. of Kansas City, manufacturers of volumetric and gravimetric feeders for dry and fluid materials. Known widely for its peacetime products, Builders has been active in four wars producing vital equipment for the Army and Navy.

Cochrane Awarded Second Star for "E" Flag

The employees and management of the Cochrane Corp., Philadelphia manufacturers of water conditioning apparatus, steam power plant equipment and flow measuring instruments, have been notified by the Navy Department of the second renewal of the "E" Production Award granted last February, signified by the addition of a second star to their "E" pennant.

Frederick P. Huston Placed in Charge of Railroad Development at Inco D. & R.

T. H. Wickenden, Manager of the Development and Research Division of The International Nickel Co., Inc., announces that Frederick P. Huston has been placed in charge of the Division's railroad developments in the application of nickel alloy steels, cast irons, Monel and other nickel alloys.

Mr. Huston has been associated with the Inco Mill Products Div. since June, 1940, devoting considerable time to the problems of steam locomotive maintenance, particularly boilers and fireboxes. His new position in Development and Research brings his return to the same division in which he entered the employ of the company in October, 1927, as Technical Service Engineer.

He aided in the development of methods

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used for the production of nickel-clad steel plate and is co-inventor of a process used for producing Inconel-clad or stainless-clad plate.

Mr. Huston studied engineering at the University of Missouri and was graduated in 1912 with a degree of B.S. in Electrical Engineering. His work and interest for the past twenty years has been in the field of mechanical and metallurgical engineering. Mr. Huston is a member of the American Society of Mechanical Engineers' General Committee of the Metals Engineering Division and General Committee of the Railroad Division and is a member of the Staybolt Committee of the Master Boiler Makers Association.

Wickwire Spencer Appoints A. S. Rairden Wire Rope Sales Manager

The Wickwire Spencer Steel Co. announced today the appointment of Mr. A. S. Rairden as Sales Manager of the Company's Wire Rope Div.

Mr. Rairden, well known in the steel industry, was previously with Carnegie Illinois, American Steel and Wire, and American Chain and Cable. He was also associated with Wickwire Spencer for 10 years as Sales Engineer and Wire Rope Sales Manager.

Mr. Rairden is an outstanding authority on Wire Rope manufacturing and application techniques. As a member of the Manufacturers Committee he assisted in the preparation of Wire Rope specifications for the National Bureau of Standards and the Army and Navy Aeronautical branches. He is also the author of many articles and scientific treatises on Wire Rope application.

Lincoln Electric Names W. R. Persons Assistant Sales Manager

The appointment of W. R. Persons as assistant sales manager has been announced by J. F. Lincoln, President of The Lincoln Electric Co., Cleveland, Ohio, world's largest producers of arc welding equipment. In his promotion to this new post, Mr. Persons will act as assistant to C. M. Taylor, vice president and general sales manager.

Among his activities concerned with the advancement and supervision of the entire Lincoln sales program, Persons will assume the responsibility of developing certain specific fields for Lincoln products. In this connection he has been working on special assignments since his transfer to the Lincoln home office at Cleveland several months ago. He is also chairman of the firm's Junior Board of Directors.

Mr. Persons has been with the company for the past ten years. Born in Painesville, Ohio, in 1909, he obtained his college education at Case School of Applied Science where he received an M.S. degree in engineering.

During his college years he took an active interest in atheletics, playing end on the football team and center on the basketball team. He also made a name for himself in high-jumping, discus throwing and shot putting events. He was a member of the S.A.E. social fraternity and Sigma Xi honorary scientific fraternity.

When he finished school, having decided to enter the fast growing industry of welding, he applied to The Lincoln Electric Co. for a job. Being told there was nothing open, he determined to make a place for himself and took the company's welding course and insisted on helping the instructor on his own time in order to get experience. Being impressed by his sincerity and determination, "Buck" as he is commonly known in the industry, was assigned to the position of

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sales and service representative in western Pennsylvania. Four years later, he was appointed branch manager of the firm's Pittsburgh office, continuing at this post until his transfer to Cleveland last year.

While at Pittsburgh, Persons was particularly active in local organizations and civic affairs. He was responsible for the development of numerous welding engineering programs in western Pennsylvania and West Virginia, was a director of the Pittsburgh Junior Chamber of Commerce, and chairman of the city's Man-Marketing Clinic. He also held memberships in the executive council of the Boy Scouts of America and the Chartiers Country Club. He is a member of The American Welding Society.

Westinghouse Announces Industrial Electronics Division

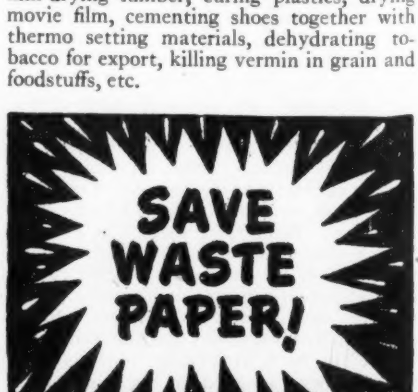
Official changes in names of two divisions of the Westinghouse Electric & Manufacturing Co., to better describe their expanding functions now and postwar, have been announced by Walter Evans, Westinghouse Vice President in charge of all Company radio, radar and electronics activities.

Involved in the changes are the former Radio Division, which now becomes the Industrial Electronics Division, and the former Radio Receiver Division, which becomes the Home Radio Division. Each will continue under its present direction, according to Mr. Evans—C. J. Burnside, for the past three years manager of the Radio Division, will head Industrial Electronics; and Harold B. Donley, named manager of the Radio Receiver Division at its organization last year, will head the Home Radio unit.

Announced at the same time was removal of the Home Radio Division from temporary quarters in Baltimore to a permanent location in Sunbury, Pa. This is in keeping with plans announced last year, Mr. Evans said, under which all postwar production of radio and television receivers will be coordinated in the Pennsylvania plant.

Phenomenal developments in the radio science over the last two decades—and particularly to insure more and finer equipment in the present war—are responsible for the changes, Mr. Evans explained. "Twenty-five years ago, when broadcasting was first introduced to the world at KDKA, Pittsburgh—and for nearly 20 years thereafter—the word 'radio' meant just one thing . . . communications. Our Radio Division came into being in this era and the name was chosen as best describing the variety of research, development and manufacture for the radio communications industry which then occupied its complete facilities.

"By the middle thirties, however, radio's high frequencies were being put to other and radically different uses . . . in baking hams, kiln-drying lumber, curing plastics, drying movie film, cementing shoes together with thermo setting materials, dehydrating tobacco for export, killing vermin in grain and foodstuffs, etc.



"Then came the war and under its fantastic demands—demands which forced our Radio Division to increase its output by 51 times—came other applications which, although geared to war production now, hold interesting possibilities for civilian manufacture after victory."

Most spectacular of these applications, Mr. Evans said, is radar which now enables robot gunners to knock down enemy planes which their human attendants never see; and which will bring new safety for all forms of transportation after the war.

"Other services which high frequency radio now is performing for war, and which will be available to all industry in the post war era," he continued, "include reflowing of tin, a vital war service since Japanese successes in the Far East reduced our available supply of tin; bonding of plywood, now used in the manufacture of PT boat hulls; moulding of plastics; annealing of electrical steel; brazing and welding; hardening and tempering of metals; production of alloy steel; inspection of metal sheet and castings for porosity; dynamic balancing; vibration fatigue of metals; remote power line operation and metering; and high speed x-ray inspection of castings and forgings to detect internal flaws which might cause failure in service.

"Thus the word 'radio,' which has become synonymous for communications, no longer serves to identify the true scope of work in the Division and we are adopting the new and more descriptive title—Industrial Electronics Division."

The change in identification of the Home Radio Division, which will build and market radio and television receivers for homes after victory, was made, Mr. Evans said, to distinguish between this undertaking and work in the radio section of the Industrial Electronics Division which will continue to build commercial transmitting and receiving equipment for the radio industry.

Reeves Pulley
Will Move Pittsburgh Office

The offices of the W. G. Kerr Co. will be located at 520 Oliver Building, Pittsburgh 22, Pa., after April 20, 1945.

For the past ten years, the W. G. Kerr Co. have been representatives for "Reeves" Variable Speed Control Units in western Pennsylvania and part of West Virginia.

Wehmeyer Represents K. O. Lee

K. O. Lee Co., Aberdeen, South Dakota, announces that Harry A. Wehmeyer, Jr., 6923 Roberts Avenue, University City 14, Mo., has been appointed factory representative for the K. O. Lee Co. throughout the State of Missouri and the Southern half of Illinois. Mr. Wehmeyer was formerly associated with the Hastings Mfg. Co.

Wickwire Spencer Elects
Bussmann Vice President

A. G. Bussmann has been elected Vice President in Charge of Sales, Wickwire Spencer Steel Co., it was announced by E. P. Holder, President.

Currently the company is planning greatly expanded postwar sales activities. In his new position Mr. Bussmann will have complete charge of all sales and merchandising operations of Wickwire Spencer and the Company's subsidiaries.

Mr. Bussmann previously was assistant to the president of Wickwire Spencer. He has been associated with the company since 1930 and was successively Manager of the Wire and Springs Divisions, Sales Manager of the Buffalo District, General Sales Manager and Assistant to the Executive Vice President.

Long associated with the steel industry, Mr. Bussmann is well known for his contributions to production efficiency as well as his sales and merchandising work.

Mr. Bussmann will continue to be located at the executive offices in New York.

John C. Cotner Heads
New Logansport, Ind. Division
of Gerotor May

The Gerotor May Corp. of Baltimore, Md. which has been in the manufacturing business for over twenty years and is now one of the country's largest manufacturers of hydraulic pumps, has acquired the Cotner Machine Products Co. of Logansport, Indiana. John C. Cotner, a founder of the Logansport firm, has become a Gerotor May Vice-President, members of its Board, and General Manager of its new Logansport division.

The products of the new plant will remain Air and Hydraulic equipment used on machine tools, important war equipment and in industrial plants. Immediate increase in the Logansport factory facilities will follow the erection of a new building construction of which is under way. Other expansion plans call for the erection of additional wings paralleling the original building and joining the new addition.

Associated with Mr. Cotner in Logansport are Ruppert Esser, Assistant General Manager and Chief Engineer, T. D. Witters, Factory Manager, Don Thomas, Executive Sales Engineer, and Jack Marsh, Sales Promotion Manager. These men were previously with Logansport Machine, Inc., and held similar positions during the past twenty years.

J. E. Smith Joins
Wickwire Spencer Metallurgical

The Wickwire Spencer Metallurgical Corp., subsidiary of the Wickwire Spencer Steel Co., announced that J. E. Smith had joined the organization as foreman of Fabricated Parts Department.

The Wickwire Spencer Metallurgical Corp. is a recently formed subsidiary. Fine drawn molybdenum and tungsten wires and tung-

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sten carbides and dies are manufactured. Currently the Company is planning greatly increased production to meet heavy demands for its products.

Mr. Smith, before his association with Wickwire Spencer, was with the Western Electric Co. at Kearny Works, Kearny, N. J., as foreman of Inspection and Manufacturing Departments. Previously he had been with the Penn. Power and Light Co. and the Carter Machine and Electrical Manufacturing Co.

Mr. Smith will be located at the Company's plant, 260 Sherman Avenue, Newark 5, N. J.

Wickwire Spencer Appoints Henry Davis to Head Market Research and Statistical Department

The Wickwire Spencer Steel Co. announces that Henry Davis will be in charge of the Company's newly formed Market Research Department. Mr. Davis has been connected with Wickwire Spencer for some years. He was most recently in the Sales Department of the Hardware Division.

The new Research Department of the Company will be organized to supply current market data for all of Wickwire Spencer Sales Divisions. Present plans call for greatly increased sales and merchandising activities postwar. It is expected that the Research Department will contribute considerably to the success of this.

Mr. Davis will make his headquarters at 500 Fifth Avenue, New York 18, N. Y.

William A. Rock to Represent Foxboro at Corpus Christi

The Foxboro Co., Foxboro, Mass., makers of industrial instruments for measurement and control, announces that William A. Rock will be its resident engineer in the Corpus Christi area, under the direction of the Houston office. He has already taken up his new duties. His mail address is P.O. Box 1956, Corpus Christi, Texas.

Mr. Rock has spent most of his life in the Southwest and his business experience has been principally in the instrumentation of oil refineries and gas plants. Through association with some of the leading construction companies serving the petroleum industry he has had extensive practical training in the installing, operation and maintenance of the many types of instruments used in the production and refining of petroleum products.

Timken Roller Bearing Appointment

Everett C. Hite, has been appointed Combustion and Refractories Engineer in the Steel Mill Metallurgical Department of The Timken Roller Bearing Co., Canton, Ohio, according to an announcement made by Gilbert Soler, Superintendent of Quality. Hite, who lives at 813—23rd St. N.W., has been an assistant engineer in the same department.

The Steel Mill Metallurgical Development Department was organized to perform the combined functions of the Steel Mill Re-

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search Department and the Combustion and Refractories Department.

Hite, a native of Pleasantville, Ohio, was educated at Pleasantville High School and Ohio State University, where he earned the degree of Bachelor of Ceramic Engineering in 1935. He is a member of the American Ceramics Society, The Institute of Ceramic Engineering, The Society of Iron and Steel Engineers, and is the author of numerous papers on combustion and refractories subjects. He first came to work for The Timken Company in June, 1935.

Williams Appointed Pacific Coast Representative

R. A. B. Williams, 216 Professional Building, Los Angeles, Cal., has been appointed Sales Representative on drop, upset and press forgings by The Steel Improvement & Forge Co., Cleveland, Ohio, for Pacific Coast states—California, Oregon, Washington and Arizona.

Call Represents Girdler in New York

C. C. Brumleve, sales manager of the Thermex Division of The Girdler Corp., Louisville, Ky., has announced the appointment of Earle C. Call as Eastern District Representative, with offices at 150 Broadway, New York. He formerly had charge of Thermex sales in the Midwest.

Mr. Call is a native of Knightstown, Ind. He received his B.S. degree in electrical engineering at Purdue, where he also did post-graduate work. Later, he studied at Indiana Law School, Indianapolis. Before joining Thermex in May, 1943, he was associated with the Russell B. Moore & Co., consulting engineers, Indianapolis.

The Thermex Division of The Girdler Corp. manufactures high frequency equipment for drying, bonding or heat processing non-conducting materials.

Inco Development and Research Division Creates New Sections

T. H. Wickenden, Manager of the Development and Research Division of The International Nickel Co., Inc., announces the formation of the following newly created sections of the Division: Industrial Chemicals Section to be headed by O. B. J. Fraser; Corrosion Engineering Section, with F. L. LaQue in charge, and Iron and Non-Ferrous Casting Section, headed by Donald J. Reese.

Mr. Fraser has directed International Nickel's investigational work at Mellon Institute of Industrial Research, Pittsburgh, Pa., on certain problems in the chemistry and technology of nickel, embracing particular attention to the preparation, properties and uses of nickel compounds, especially organic derivatives and nickel catalysts. Through the Industrial Chemicals Section now established, Mr. Fraser can further expand the company's interests in this direction. He continues as Director of Technical Service of International Nickel's Mill Products, a position he has held since 1934. Mr. Fraser received his Bachelor of Science degree in Metallurgical Engineering in 1916 from Queen's University, Kingston, Ontario. He has been associated with International Nickel since 1917. Mr. Fraser is Treasurer of the American Welding Society, Chairman of the Nickel Alloys Committee of the Welding Research Council, and Chairman of the Sub-Committee on Refined Nickel and High Nickel Alloys, Cast and Wrought, of Committee B-2, of the American Society for Testing Materials.

Mr. Wickenden states that the function of the newly created Corrosion Engineering

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Section under Mr. LaQue will be to coordinate the broad interests of the company and its customers in the choice and applications of nickel-containing alloys where resistance to corrosion is required. After receiving his degree of Bachelor of Science in Chemical and Metallurgical Engineering from Queen's University in 1927, Mr. LaQue joined the Development and Research Division of International Nickel. Between 1937 and 1940 he was Assistant Director of Technical Service on Mill Products and since April of 1940 he has been engaged in development activities on all applications of both ferrous and non-ferrous nickel-containing alloys. He is Chairman of the American Coordinating Committee on Corrosion created to correlate American and British corrosion data.

As head of the Iron and Non-Ferrous Casting Section, Mr. Reese will coordinate more closely International Nickel's development work on cast iron, malleable iron, cast brass and bronze. He has just recently resumed his duties with the company's Development and Research Division after having been with the Steel Division of the War Production Board at Washington for almost three years. Mr. Reese joined International Nickel in 1936. He is the author of numerous technical papers on foundry operation and is a well known speaker throughout the industry. In 1941 he was awarded the J. H. Whiting Gold Medal of the American Foundrymen's Association for outstanding contributions to the foundry industry and the Association through his work in the improvement of cupola melting methods. He was graduated from the University of Michigan in 1925 with a degree of Bachelor of Science in Chemical Engineering. Mr. Reese is past Chairman of the Chicago and the Metropolitan Chapters of the American Foundrymen's Association.

Cooper Bessemer Appoints Myers to Capitol Staff

Appointment of Walter F. Myers to the staff of the Washington office of The Cooper Bessemer Corp. is announced by Stanley E. ohnson, General Sales Manager.

Mr. Myers brings to the company a broad experience in the equipment and Diesel field, having served during the past 25 years as sales engineer, construction engineer and consulting engineer for public and private corporations, including Fairbanks, Morse & Co., the Federal Power Commission and the United States Maritime Commission.

Mr. Myers will assist Charles G. Cooper, director of the Cooper Bessemer Washington office in the handling and supervision of government contracts and sales and service in the Southern Atlantic States.

The Cooper Bessemer Corp., Diesel engine and compressor manufacturers for 112 years, maintains its main plants in Mount Vernon, O., and Grove City, Pa.

Collier Elected Allis-Chalmers Director

John Howard Collier, president of the Crane Co., Chicago, Ill., was elected a director of the Allis-Chalmers Manufacturing Co., it has been announced by Walter Geist, Allis-Chalmers president, following a meeting of the board of directors.

Collier fills the post left vacant by the resignation of Capt. Lester Armour of Chicago, who has been out of the country in the service of the navy most of the time since the outbreak of the war.

After attending Purdue University, Collier joined the Crane Co. in 1903 as an apprentice foreman. He progressed steadily through many positions and was made general manager of the company in 1912. He served in this post until 1917 when he went abroad,

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serving as chairman of the board of Crane, Ltd., England, and president of Cie Crane, France. He returned to this country in 1929. In 1933 he was elected vice president of the company and served in that capacity until 1941, when he became president.

He also is associated with the Crane Ltd., Canada; Crane Ltd., Great Britain; Port Hope Sanitary Manufacturing Co., Ltd., Canadian Potteries Ltd., and Crane Enamelware Co. He is chairman of the board of the Trenton Potteries Co.

Collier is a trustee of the Illinois Institute of Technology.

Graves Appointed Sales Manager of Steel Improvement & Forge Co.

W. E. (Eddie) Graves has been appointed Sales Manager of The Steel Improvement & Forge Co., manufacturers of drop, upset and press forgings and forged boiler and tank accessories. He has been with the company for five years and has recently been in charge of priority and traffic matters.

Buffalo Forge Appoints New Sales Manager

The appointment of Charles C. Cheyney to the position of Sales Manager of Buffalo Forge Co. is announced by Charles A. Booth, Vice-President. Mr. Cheyney was for a number of years Chicago Representative of Buffalo Forge Co. and in recent years has been Assistant Sales Manager. He has a large acquaintance in the heating and ventilating field among contractors, consulting engineers and industrial engineers.

• LATEST CATALOGS

New Rotameter Catalog Contains Useful Selection Data

A new publication on Rotameters issued by Cochrane Corp. of Philadelphia contain in addition to catalog material on the Cochrane line, helpful data on the selection of a Rotameter for any particular service. Specific gravities of gases and of various metals used in floats are given, together with formulae for converting water and air capacities to terms of other liquids and gases. Other selection factors, such as pressure drop, length of scale and float material are covered in this interesting publication, No. R-100A, a copy of which may be had by addressing Cochrane Corp., Philadelphia 32, Pa.

Fluid Handling Equipment

J. A. Zurn Mfg. Co., Erie, Pa., announce their new Catalog No. 45, Fluid Handling Equipment. The products illustrated are of such a nature as will suggest means of use and application that heretofore have been left in a rather unfinished state. Space limitations do not permit elaboration on each of the lines, therefore present your particular problem as it applies in this field, so that their engineering staff can assist in the solution of whatever kindred problem you may have.

Porter Publishes New Diesel-Electric Locomotive Catalog

H. K. Porter Co., Inc., builders of locomotives since 1866, have just issued a new 44-page catalog on Diesel-Electric locomotives.

In addition to giving complete specifications on both narrow and standard gauge locomotives ranging from 30 to 100 tons, the

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catalogue reveals pertinent engineering and construction data. Diesel-Electric advantages and necessary information for selecting the proper type of locomotive are also considered.

A copy of this catalogue, #L-45-A, may be obtained by writing to H. K. Porter Co., Inc., Pittsburgh 22, Pa.

Single Stage Double Suction Pumps

As a war time service to men of industry who are maintaining production in spite of man-power turnover, Economy Pumps, Inc., Hamilton, Ohio is now distributing the first catalog in a series of new "Know How" manuals on pumps. When the series of approximately ten manuals are completed they will be furnished in stiff cover binders.

Economy will be glad to furnish copies of this catalog on Single Stage Double Suction Pumps to plant executives requesting same.

Boiler Baffle Walls

Bulletin BW-44, 20 pages, containing valuable useful data on modern Baffle Wall design and construction for all water tube boilers. The Engineer Co., 75 West St., New York 6, N.Y.

Liquid and Gas Fuel Burners

Bulletin OB-37, 16 pages, showing variety of types of Oil and Gas Burners. Also Liquid Fuel Pumping and Heating Equipment of various sizes to handle all types of Fuel Oil or Tars to meet any capacity for all types of Burners. The Engineer Co., 75 West St., New York 6, N.Y.

Handbook on Employee Suggestion System Distributed by Cooper-Bessemer

A generously illustrated 40-page handbook containing details of The Cooper-Bessemer Corp.'s recently adopted Suggestion Plan, is being distributed to the company's employees in its Mount Vernon, Ohio, and Grove City, Pa., plants.

The company's suggestion plan has already brought forth hundreds of recommendations from employees which have increased efficiency and reduced the manufacturing cost of its Diesel engines and compressors.

The booklet covers in sufficient detail all phases of the award system which primarily is based on the payment to employees of awards aggregating ten per cent of the net savings resulting from suggestions or five per cent of the gross savings, whichever is larger, on the basis of one year of its operation. The award plan also provides payment for intangible ideas suggested and these awards are determined by an Appraisal Board appointed to administer that phase of the co-operative program.

Each booklet is personalized by provision for the name of the employee on the front cover.

In addition to the cash awards, the Cooper-Bessemer suggestion plan includes the distribution of award pins to winners. A sterling silver pin is awarded for suggestions that win up to $50 and a solid gold pin for awards of $50 and over.

The company is considering additional yearly awards for ideas of greatest benefit during that current period.

The new Suggestion Plan booklet is carefully planned and unusually attractive. It is 6 by 4½ inches and serves as a companion piece to Cooper-Bessemer's "Partners in Industry" which has been distributed to new employees and which provides information about the company's policies, facilities, safety

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rules and a history of its tremendous growth and development over a period of 111 years of distribution of Cooper-Bessemer Diesel engines and giant compressors in the maritime, railroad, oil and gas and other of the world's key industries.

Copies of both booklets are available for distribution to industrial concerns planning the inauguration of either a Suggestion Award Plan or a program of preparation for new employees.

Cochrane Direct Contact Open Heater

Cochrane Corp. 17th St. & Allegheny Ave., Philadelphia 32, Pa., have just released a very interesting bulletin treating on open feed water heaters of various types. Publication 4091 illustrates and describes different types of tray heaters for various applications, the jet heater, V-notch metering heater, also the convertible tray type of heater, which by the insertion of additional trays can be converted into a deaerator.

The bulletin is profusely illustrated showing various combinations of heaters with storage tanks and should be of interest to engineers interested in heating water for boiler feed or process requirements.

Rotoblast Special Machine Booklet

A new 24-page booklet featuring 21 unusual problems in blast cleaning that required special "made to measure" equipment for production handling is being distributed by the Pangborn Corp., world's largest manufacturer of blast cleaning and dust control equipment, Hagerstown, Md.

Based on the often heard theme of "My problem is different," the contents of the book—both pictures and text—is quoted as "the most diverse group of blast cleaning machines in the country. Some operations use the airless Rotoblast method, some utilize air. The work they blast clean is large, small, intricate, simple, unusual shapes and fragile. Almost every known method of handling metals to be processed is represented, yet these machines have one thing in common. Each of these machines was designed by Pangborn engineers after a thorough study of the cleaning problems and their relation to the production line."

The pictures are large and numerous. Two feature bomb and shell cleaning. The balance range from automatic handling of bathtubs and sanitary wear to miscellaneous automobile parts.

Copies of this interesting booklet will be mailed free to industry as long as the supply lasts. Write to Pangborn Corp., Hagerstown, Md.

Motor Driven Vent Sets

A new data bulletin on motor-driven vent sets has been issued by Buffalo Forge Co., Buffalo, N. Y. This Bulletin, No. 3499, gives physical data, dimensions and ratings on "Limit-Load" belt-driven fans up to size 5, on cast iron "Baby" vent sets, on direct-connected "Limit-Load" Fans up to size 4-1/2, and on "Shortboy" Units in capacities up to 20,700 cfm.

The fans listed in this bulletin are largely used for industrial and commercial ventilating work.

More Steam at Lower Cost

An 8-page bulletin describing the new AE Perfect Spread Stoker, with photographs, cross-sections and drawings. The stoker burns all kinds and grades of solid fuels thoroughly, wet or dry. Completely automatic, extremely quiet operation with non-clog, variable speed feed. Uniform overthrow spreading; combustion by exclusive

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"cross-firing." Streamlined design provides utmost protection and accessibility. Cuts fuel bills and boosts operating efficiency. Write American Engineering Co., Philadelphia 25, Pa.

Electronic Resistance Thermometer

Bailey Meter Co., Cleveland 10, Ohio, has published Bulletin No. 230-A featuring Bailey Pyrotron Electronic Resistance Thermometers in indicating, recording and controlling models, for temperature ranges between the limits of minus 100 degrees F. and plus 1200 degrees F.

The instruments are said to be well suited for marine, mobile or other classes of severe service since no galvanometers or millivoltmeters are used. No parts move in the measuring circuit except during temperature changes.

The 12-page bulletin lists outstanding features; describes the electronic detector and motor control; gives definite information on: ranges, power supply required, speed of response, accuracy, sensitivity, installation, standard chart ranges, automatic control application, alarm contacts, temperature sensitive elements, and measuring circuits.

New Air-Actuated Twin Disc Clutch

The Twin Disc Clutch Co., manufacturers of industrial clutches and hydraulic drives, describes its new air-actuate clutch, ideal for remote control set-ups and where "feather-touch" engagements in heavy-duty operations are necessary, in a new, eight-page engineering bulletin, No. 139.

The new clutch is known as the Twin Disc Model P Air-Actuated Clutch. It retains many of the features of the familiar heavy-duty Twin Disc Model E (friction) Clutch and may be used in many of the same types of installations as the latter clutch.

The Model P has a hub and back plate, center plate, floating plate and friction discs of essentially the same proportions as the

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model E, and is manufactured in a wide range of sizes, from 14" to 36", and capacities, 65 to 895 horsepower.

The air-actuated clutch operates by remote control without a complicated linkage system and shaft space is greatly reduced. It has ideal operating characteristics because any amount of air pressure—within limits—can be applied to the friction plates to provide either slow or fast engagement. Few moving parts are employed to assure easy maintenance.

The Model P design provides two different methods for handling the actuating air supply, depending upon where the clutch is mounted: First, by drilling the shaft and using an end shaft rotary air seal; second, by using a special shaft-a-round, or mid-shaft rotary air seal.

Copies of Bulletin No. 139 may be obtained by writing the Twin Disc Clutch Co., Racine, Wis.

Abrasive Cutting

A new 8-page catalog just released by the Andrew C. Campbell Div. features the Campbell Hudorkut Model No. 1 Abrasive Cutting Machine.

In this catalog are pictures of the machine, both interior and exterior, pictures of typical pieces cut and close-ups of the cutting action. Campbell Hudorkut Machines are designed to cut up to 4" stock, smoothly and cleanly. All cutting is done by immersing the work in coolant. It will cut practically any material. This machine is ideal for laboratory or metallurgical work.

For your copy of this catalog complete with specifications and details of the Campbell Hudorkut Abrasive Cutting Machine, write to: Andrew C. Campbell Div., American Chain & Cable Co., Inc., Bridgeport, Conn.

Heaters and Coolers

A new, 12-page, loose-leaf, $8^1/_2 \times 11$ two color Bulletin No. 35-76B on "Adsco" Heaters and Coolers includes three new types with dimensions, capacity tables and list prices on units suitable for use as instantaneous heaters, condensate coolers, preheaters, fuel oil heaters, etc. A copy of the bulletin will be sent upon request to the American District Steam Co., North Tonawanda, N. Y.

Tube Cleaning Procedure Suggestions

Correct steps to be taken before, during and after a tube-cleaning operation to insure highest efficiency are outlined in a new service bulletin just issued by Thomas C. Wilson, Inc.

Supplied in the form of a step-by-step check list, this information covers selection of appropriate equipment, proper cleaning procedure, care of cleaning equipment, and listings of types and sizes of motors, cutters, brushes and other accessories required. Illustrations identify the equipment described and recommended.

Copies of this new check list—Bulletin No. 75—may be obtained by addressing Thomas C. Wilson, Inc., 21-11 44th Ave., Long Island City 1, N. Y.

Aircraft Screw Products New Bulletin

A new bulletin has just been published by Aircraft Screw Products Co., Inc.

Bulletin No. 239 is designed to give the reader a condensed picture of "Heli-Coil" Inserts and the "Aero-Thread" Screw Thread System. It includes elementary engineering data; brief statements of the advantages of these two designs; typical applications of both; and material on the tools needed for installation.

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"Heli-Coil" Inserts are precision-shaped helical coils of stainless steel or phosphor bronze wire that provide a protective lining for tapped threads in materials with relatively low tensile strength.

The "Aero-Thread" Insert is similarly constructed but has a special thread form to fit the "Aero-Thread" Screw Thread System profile, consisting of a circular section in the screw or stud and a truncated Vee in the tapped hole. 100% increased fatigue resistance and 25% greater static strength is claimed for this special thread form.

New All-Directional All-Purpose Vibration Control Unit

The newly developed Korfund Type SL Universal Vibro-Isolator is described in detail in a four-page bulletin recently published by The Korfund Co., Inc., of Long Island City, N. Y., makers of vibration control equipment. The bulletin points out that the ability of the unit to absorb vibration in all directions makes it an effective vibration control for a wide variety of applications, including: Punch presses, shears, hammers, grinders, shakers, Diesel engines, generators, panel boards, material testing equipment, recording apparatus, business machines and ventilating and air conditioning equipment. It is said to be particularly effective in cushioning impacts from all horizontal directions where unbalanced forces, centrifugal action or external belt pulls are encountered.

The bulletin contains complete data regarding the rated loads, weights and dimensions in the six basic sizes in which the Type SL Vibro-Isolator is made. According to these data the load capacity of the different sizes ranges from 200 to 12,000 lbs.

Construction details illustrated and described in the bulletin show the combination of adjustable steel springs for the control of vertical vibration with self-adjusting resilient inserts for controlling lateral vibration.

Copies of this bulletin may be obtained by writing to The Korfund Co., Inc., 48-15 Thirty Second Place, Long Island City 1, N. Y.

AE Improved Type "R" Taylor Stoker

A 20-page booklet showing detailed operating views and drawings of the improved features that add new efficiency to time-tested principles of the Taylor Multiple Retort Underfeed Stoker. Facts on simplified construction installation, operation and maintenance describe advantages in more thorough combustion, less frequent outages, lower costs. Write American Engineering Co., Philadelphia 25, Pa.

New Link-Belt Catalog on Couplings

A new, 8-page, illustrated Book No. 2045 on a complete line of shaft couplings, is announced by Link-Belt Co.

Sizes, dimensions and list prices are given for couplings of flexible, rigid flanged face and compression types, with special emphasis on the Type "RC" Roller Chain Coupling.

Detailed information is also given on protective casings for the "RC" coupling. This includes two styles of revolving casings ("R and "P") and a type "S" stationary-mounted casing. The Type "P" is a plastic casing; the others are made of steel.

A copy of new Book No. 2045 may be obtained by writing direct to Link-Belt Co. at Philadelphia, Chicago, San Francisco, or other office of the company.